June 3, 2003

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World Health Organization
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Re: 61st JECFA meeting, 10 June 2003

Dear Dr. Page:

In early June, the Joint FAO/WHO Expert Committee on Food Additives (JECFA) will consider revising the Provisional Tolerable Weekly Intake (PTWI) for methyl mercury. To support this discussion, Dr. Michael Bolger and colleagues drafted a review of the literature several years ago. This 2000 review, *(*included in *WHO Food Additives 44),* takes stock of a wide literature but concludes that inconsistencies between two key epidemiological studies -- the Faroe Islands and Seychelles studies -- are of such a magnitude as to preclude a revision or update of the W.H.O. permissible exposure level for methyl mercury.

We are writing to call attention to a number of important research findings and key policy developments over the past three years that merit attention. The research developments are detailed in an attachment to this letter but can be summarized as follows:

- Some scientific issues related to the Faroe Islands study, particularly the possibilities of PCB confounding and bolus exposures to methyl mercury in that work, have been resolved, leading to greater confidence in the results of these studies;

- Tests on the Faroe Islands children's cohort have continued as the children have matured, providing additional evidence of neurological and other impacts beyond seven years of age;

- Evidence is continuing to emerge linking increased risk of coronary heart disease to mercury exposure, with the publication of at least two additional studies; and

- Substantial evidence is accumulating that exposure to methyl mercury is widespread in the general public and occurring at higher than health-based levels of concern.

Since 2000, national and international food safety authorities have adopted lower limits on methyl mercury exposure and/or stronger warnings designed to help sensitive populations, particularly pregnant women and children, avoid or reduce exposure. In particular:

- The U.S. Environmental Protection Agency (EPA) has recommended a reference dose (RfD) of 0.1 μg/kg body weight per day for methyl mercury. EPA has also issued a general fish consumption advisory for methyl mercury advising women who are or may become pregnant, nursing mothers and young children to limit consumption of freshwater fish based on its RfD.

- The National Research Council of the US National Academy of Sciences (NRC) has reviewed the evidence as a whole and has concluded that the Faroe Islands study, rather than the Seychelles study, is the most appropriate study for deriving a Reference Dose and that the two studies should be seen in conjunction with an important New Zealand study. An NRC committee recommended the EPA reference dose of 0.1 ug/kg/d as appropriate.

- The European Commission has endorsed the US EPA's reference dose as the appropriate methyl mercury exposure standard.

- The Food Standards Agency of the United Kingdom (FSA) has advised pregnant and breastfeeding women, and women who intend to become pregnant, to limit their consumption of tuna to no more than two medium-size cans or one fresh tuna steak per week, and

- The United Nations Environmental Programme (UNEP) Governing Council has agreed that there is sufficient evidence of significant global adverse impacts from mercury and its compounds to warrant further international action to reduce the risks to human health and the environment. It is now developing a plan to raise global awareness of the critical need to sharply reduce human exposures to mercury.

These expert deliberations have reached consistent conclusions about methyl mercury toxicity by considering the increasing weight of evidence for methyl toxicity at low levels.

Approximately two weeks ago, The Lancet published an update of the Seychelles study. While the finding was negative, this paper sheds light on two of the possible reasons for inconsistencies between results from the Seychelles, Faroe Islands, and New Zealand work to date: the differences between the studies in age of testing, and endpoints used in neurotoxicological assessments.

Unfortunately, the reasons for the different results from these studies remain unclear. The NRC had identified random variability in outcome determination related to statistical power as the most plausible explanation for discrepancies among results. Such varying outcomes are by no means unusual in large-scale epidemiologic studies and remain a strong possibility. Since the most recent findings from the Seychelles reflect determinations on the same cohort as that evaluated in the studies reviewed previously by the NRC, the same limitations due to statistical power would be expected in the follow-up. Misclassification of exposure, stemming from both the use of maternal hair as an exposure measure and the recruitment of women into the study six months post partum, by necessity, also remains an issue in the recent update, as well as questions which have been raised about cultural differences and language issues that could have limited the accuracy of a key neurotoxicological endpoint measurement, the Boston Naming Test.

While both the Seychelles and Faroe Islands studies are well designed and well executed, the NRC concluded on the basis of careful consideration that the positive findings of the Faroe Islands and other works could not properly be discounted by the negative findings of the Seychelles study. Nothing in the Seychelles update changes the balance for this conclusion.

Furthermore, prudent public health practice dictates that when authorities are confronted with both positive and negative studies and there are irresolvable uncertainties as to which results are more generally applicable, guidance should be derived from the studies showing adverse outcomes rather than from negative studies. In the case of methyl mercury, indications of adverse effects are buttressed by the positive findings from the New Zealand study as well as in studies from French Guiana and the Amazon. The weight of evidence on methyl mercury is enhanced by a large docket of in vivo and in vitro results, as well as by recent epidemiological studies concerning potential adverse cardiovascular effects at relatively low levels of exposure.

We believe that the time is ripe for JECFA to reduce the Provisional Tolerable Weekly Intake for methyl mercury at its upcoming meeting in Rome. We suggest that the science strongly supports the determination by the U.S. EPA of a reference dose of 0.1 ug/kg body weight per day, which is consistent with recommendations that whole blood mercury levels not exceed 5.8 μg/L (ppb) or the hair level not exceed 1.0 ppm. We urge JECFA to recommend exposure limitations consistent with these indices.

Attached is a more detailed summary of the most important developments on mercury toxicity that have come to light since JECFA last met to discuss methyl mercury in the diet. We hope that this information proves useful to your deliberations.

Sincerely,

Attached Signatories

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Attachment

Important Developments in Scientific Evidence on Methyl Mercury Toxicity and Exposure, and Policies on Permissible Exposure Levels, 2000-2003

Introduction

Methyl mercury poisoning incidents, particularly the well-known incident in Minamata, Japan, have documented links between exposure and neurotoxicological effects.[i] Three prospective epidemiological studies, in the Faroe Islands, the Seychelles, and in New Zealand, have been singled out over the past five years for the development of dose response calculations. The study in the Faroe Islands documented subtle deficits of several functional domains at prenatal methyl mercury exposure levels previously thought to be safe.[ii] This finding was in agreement with a prospective study in New Zealand[iii] as well as cross-sectional epidemiological studies in French Guiana[iv] and the Amazon[v] that also showed effects but do not lend themselves to dose response analysis. However, results from the Seychelles have not been concordant; to date, this prospective study has not shown effects[vi], [vii]. There have been hundreds of toxicological studies delineating toxic impacts of methyl mercury on animals and in vitro over the past decades, as well as additional epidemiological studies suggesting toxic effects beyond developmental neurotoxicology .

Important Recent Evidence on Methyl Mercury Toxicity

Some scientific issues related to the Faroe Islands study, particularly the possibilities of PCB confounding and bolus exposures to mercury, have been resolved.

Questions have been raised about confounding factors in the Faroe Islands studies that could have affected observed associations between exposure to methyl mercury and neurodevelopmental outcomes in the latter study. The National Research Council performed analyses that addressed this issue specifically with regards to the Faroe Islands study and concluded that although there were effects associated with both PCBs and methyl mercury, these effects are independent.[viii] The Faroe Island researchers have subsequently found "...PCB-associated neurotoxicity could be latent in this population and may be unmasked at increased methyl mercury exposures. Parallel calculations for mercury showed remarkably different results. The mercury-associated neurobehavioral deficits were quite similar within the three-tertile PCB concentration groups with the mercury regression coefficients in the lowest PCB tertile tending to be the greatest. ...These results indicate that the mercury-associated effect is unlikely to be affected by PCB exposure to any great extent."[ix]

Concerns had been raised regarding confounding of maternal age and the presence of older siblings at home. However, a detailed analysis has indicated that these

parameters will not alter the analysis, and results obtained with these two covariates along with 18 others did not affect the results.[x]

Finally, it has been suggested that the Faroe Islands study reflected only the effects of "bolus" (acute, intermittent) doses of mercury, while the Seychelles captured chronic exposure more typical of dietary intake in many cultures. However, an analysis of hair-mercury profiles has since suggested that the pattern of mercury exposure rates over time in the Faroe Islands and the Seychelles studies are similar. Additionally, an analysis eliminating the infants of women with the most highly variable hair mercury levels resulted in a stronger association between mercury exposure and adverse neuropsychological outcome. [xi] Furthermore, and perhaps more importantly, a recent article by Hightower et al. (2003) has demonstrated that many Americans are exposed to "bolus" mercury consumption through commercial fish such as Ahi or other tuna steaks, Sushi, and swordfish. Mercury levels in these fish species raised blood mercury levels several fold in individual subjects who consumed them. Some blood mercury levels observed by Hightower et al. were higher than the levels seen in both the Seychelles and Faroe Islands studies [xii].

Also in the past three years, new information has become available on neurological status at two weeks of age in the Faroese Cohort 2, born in 1994-1995 and originally reported in Steuerwald et al. (2000).[xiii] This study examined 182 infants born in the Faroe Islands, along with corresponding levels of mercury in maternal serum, hair, milk and umbilical cord blood. This study found that the neonatal neurological status (measured in the Neurological Optimality Score, or NOS) was significantly poorer at higher blood-mercury concentrations. The authors report that, "exposures to methyl mercury and polychlorinated biphenyls were increased in relation to maternal seafood intake... After adjustment for confounders, including PCB body burden, a 10-fold increase of the cord-blood mercury concentration was associated with a decreased neurologic optimality score of 2.0 (P =. 03). This effect corresponds to a decrease in gestational age of about 3 weeks." The neonatal NOS assessment has been used as an important predictor of neurological risk later in childhood, and extensive results from a project in Groningen in the Netherlands have shown that the neonatal NOS has a high specificity (but a low sensitivity) for subsequent development of minor neurological dysfunction.[xiv] These findings support the validity of the neonatal assessment using the NOS methodology, and they are in accordance with the exposure-associated effects seen in older children.

Finally, the impact of mercury on overall growth and development has been further supported by data published since 2000. In the Faroese Cohort 2, pre and postnatal methyl mercury exposure was found to be associated with decreased postnatal growth, particularly before 18 months of age. The authors found that, "irrespective of duration of breast-feeding, a doubling of the mercury concentration in cord blood was associated with a decrease in weight and height." [xv]

Tests on the Faroe Islands children's cohort have continued as the children have matured, providing additional information on neurological and other impacts beyond seven years of age.

The Faroese study has been updated to include state of the art neurological testing administered to the cohort of children under study as they have matured. In the 1997 report of the Faroes study, examinations of children at age 7 had included several probes into CNS-mediated functions such as past achievement of developmental milestones, plus sensitive measures of neurological function, such as evoked potentials, visual and auditory acuity, and neuropsychological functions.[xvi] Subsequently, during re-examination of the same cohort of children at age 14, these measures were broadened to include social adjustment and measures of academic knowledge and achievement; a pilot study has also been done with a subset of the children at age 16 using functional and structural neuroimaging techniques to probe CNS correlates of methyl mercury exposures. In a lecture delivered at the International Joint Commission for the Great Lakes in February, 2003, the principal investigator of the Faroes study, Dr. Philippe Grandjean, reported that the results of the 14-year follow-up were in agreement with the earlier findings of developmental effects (1997). The authors now find that results of mercury exposure include delays of the brainstem auditory evoked potentials, a neurophysiological measure of neurotoxic effects known to be independent of socioeconomic confounders.

Additional evidence of increased risk of coronary heart disease due to mercury exposure, first reported in 1995, has emerged with the publication of additional studies.

Several studies have linked mercury exposure to cardiovascular disease. These studies are important because consumers are advised to eat fish to protect against heart disease. Some fish species contain beneficial omega-three fatty acids, and fish is a low-fat source of protein. However, recent studies raise the possibility that moderate mercury content in fish may in fact diminish the cardio protective effect of fish intake. Salonen et al. (2000) reported an association between moderate hair mercury content and accelerated progression of carotid arteriosclerosis (determined by ultrasonographic assessment of common carotid intima-media thickness), in a prospective study among 1014 men aged 42-60 years in Finland. Hair mercury levels greater than 2 ppm (well within the range of the U.S. adult population) showed a doubling of the risk of cardiovascular mortality in this study. [xvii]

Recently, Guallar et al. (2002) reported in the New England Journal of Medicine that toenail mercury level (an indicator of exposure) was directly associated with the risk of myocardial infarction.[xviii] This case-control study was conducted in eight European countries and Israel, and studied 684 men with a first diagnosis of myocardial infarction. The authors report that the mercury levels in the patients were 15 percent higher than those in controls (95 percent confidence interval, 5 to 25 percent). The risk-factor-adjusted odds ratio for myocardial infarction associated with the highest as compared with the lowest quintile of mercury was 2.16 (95 percent confidence interval, 1.09 to

4.29; P for trend=0.006). The authors suggest certain mechanisms that may be contributing to this effect, including inactivating the antioxidant properties of glutathione or catalase, inducing lipid peroxidation, promoting platelet aggregability and blood coagulability, and affecting the inflammatory response, among several others.

A third study on cardiovascular health was unable to replicate the findings of Guallar et al. However, the study population consisted largely of dentists who had an occupational exposure to elemental mercury. Since mercury exposure measurements in this study were based on total mercury, the elemental mercury exposure could have confounded detection of a methyl mercury effect. In fact, when the dentists were removed from the study, an association with cardiovascular outcomes (albeit not statistically significant, probably due to the smaller sample size) was seen with mercury exposure. [xix]

The posited association between methyl mercury and heart disease suggests that long-term mercury exposure, even at very low levels, may contribute to a disease that is responsible for one third of all deaths globally in 2000. In that year the World Health Organization predicted that heart disease would be the number one cause of death in developing countries by 2010.[xx] It was the number one killer of Americans in 2000, causing 257.9 deaths per 100,000 population in the U.S. The medical and social costs of heart disease are staggering. We believe the emerging evidence of an association between chronic low-level mercury exposure and this major modern cause of death deserves to be given significant weight in JECFA's review.

Important Recent Evidence on Methyl Mercury Exposure

New evidence has come to light that exposure to methyl mercury is widespread and occurring at levels exceeding health-based recommended limits. Just a month ago, for example, the Journal of the American Medical Association (JAMA) published results from an extensive survey of the U.S. general population that bolsters previous findings of concern about blood mercury levels in fish-consuming subpopulations including recreational anglers, subsistence fishers, and American Indian and Alaskan Native groups.

Although it has long been recognized that mercury is widespread in the environment and that exposure occurs primarily through consumption of fish and shellfish which have bioaccumulated methyl mercury, information about the distribution of blood mercury levels in the general population has been lacking, and hence it has been difficult to fully evaluate the public health significance of the mercury problem. Exposure information for women of childbearing age has been particularly urgently needed, since fetal exposure is known to be a critical window of exposure to the compound.

In the April 2003 issue of JAMA, Schober et al. reported the results of the first 2 years of the U.S. NHANES (National Health and Nutrition Examination Survey,

conducted by the US Centers for Disease Control and Prevention) study, which was measured blood mercury levels of 1709 women of child-bearing age and 705 children in the general population from across the country.[xxi] Eight percent of reproductive-aged women had blood mercury levels higher than 5.8 μg/L, below which exposures are considered to be without adverse effect by US EPA. Mercury levels were 3 times higher in women than in young children, which the authors speculate may be due to differences in toxicokinetics, dose-body size relationships, dose frequency, or unknown sources of mercury exposure in adults. Blood mercury levels were associated with self-reported fish consumption in the past 30 days for both children and women; among women, blood mercury levels were almost 4-fold higher in women who reported eating 3 or more fish meals in the past month, compared with those who ate no fish over the same time period. The authors expressed particular concern for those women who are pregnant, or who may become pregnant.

A 2001 publication of Stern et al. (2001) also found widespread exposure to mercury in the general population. These authors determined hair and blood mercury levels in mainly first-trimester pregnant women in New Jersey and found that approximately 10 percent had levels exceeding the USEPA RfD and that 1 to 2 percent of the women had hair mercury levels exceeding 4 μg/g, "in the range of possible concern for adverse developmental effects".[xxii]

Finally, Hightower et al. (2003) recently published a study finding that 89 adult patients in San Francisco who reported diets high in fish consumption had mean blood mercury level of 14.5 μg/L (ppb) and a median of 11.2 μg/L. The mean level for women in this survey was 10-times higher than the U.S. national mean of 1.3 μg/L (NHANES, CDC).[xxiii]

These three publications, taken together, confirm that the general population, at least in the U.S., is routinely exposed to mercury doses higher than those presumed to be safe. The recent data are notably in accordance with a prediction by a committee of the National Research Council of the U.S. National Academy of Sciences, which assessed methyl mercury exposure and toxicity in 2000. The growing evidence of relatively widespread excessive exposure lends urgency to the JECFA re-evaluation at this time.

Emerging Consensus Among National and International Authorities

Following extensive study and *de novo* analysis, the US National Research Council (NRC) concluded that the Faroe Islands study provided the single best basis for evaluating the toxicity of methyl mercury. Significantly, integrative analysis using all three studies also supported this conclusion. Furthermore, NRC concluded that EPA's RfD for methyl mercury (0.1 ug/kg per day) was scientifically justified.

In 2000, an expert committee convened by the U.S. National Research Council (NRC) reviewed methyl mercury exposure and toxicity with regard to identifying appropriate methods for setting a reference dose. The NRC assessment concluded that certain strengths of the Faroe Islands study – its large study population, its use of two

measures of exposure (maternal hair and cord blood), its extensive peer review in the epidemiological literature, and the re-analysis of its raw data in response to questions the NRC itself had submitted to the researchers -- made the Faroe Islands study the most appropriate basis for deriving an RfD.[xxiv]

The NRC committee recognized that the Faroe Islands population had been exposed to relatively high levels of PCBs and agreed that this was a potential issue of concern. Consequently, it undertook its own reanalysis of the data. It concluded that the adverse effects found in the Faroe Islands study were not solely attributable to PCB. Moreover, the NRC committee noted that the results from New Zealand demonstrated neurological effects associated with methyl mercury exposure at similar levels to the Faroe Islands study, and without the potential for co-exposure to PCB's.[xxv]

Although the NRC committee recommended that quantitative risk assessment be based on the Faroe Islands study, it also explored a weight-of-evidence approach based on an integrative analysis that allowed a quantitative synthesis of information across all three epidemiological studies. This is consistent with US EPA practice to consider the weight of evidence of the available literature when deriving the basis for an RfD. To do this, the NRC relied upon a hierarchical random effects model designed to take proper account of appropriate study-to-study and outcome-to-outcome heterogeneity across the studies. Such a model provided a useful tool for separating random versus systematic variation and thereby provides more stable estimates of study-specific and outcome-specific benchmark doses. The effect of the hierarchical modeling was to smooth away much of the random variability observed in the original data, particularly the more extreme values. Significantly, the integrative analysis resulted in a point of departure of 32 ug/l in blood, lower than the 58 ug/l for the Boston Naming test in the Faroe Islands study.

After reviewing and taking into consideration the evidence on carcinogenicity, immunotoxicity, reproductive effects, renal toxicity, cardiovascular effects, and central-nervous-system toxicity which was available in many studies outside of the Seychelles and Faroe Islands epidemiological works, selecting an end point for the RfD, examining the critical studies for the RfD, and assessing the need for uncertainty factors, the NRC committee concluded that EPA's RfD of 0.1 ug/kg per day was scientifically justifiable for the protection of public health. The committee further estimated based on the data that over 60,000 children are born in the U.S. each year at risk for adverse neurodevelopmental effects due to *in utero* exposure to methyl mercury.[xxvi]

The U.S. Environmental Protection Agency (EPA) developed a reference dose (RfD) of 0.1 µg/kg body weight per day for methyl mercury. This is calculated to correspond to a whole blood mercury level below 5.8 µg/L (ppb) or a hair level below 1.0 µg/g (ppm). EPA has also issued a general fish consumption advisory for methyl mercury based on its RfD, advising women who are or may become pregnant, nursing mothers and young children to limit consumption of freshwater fish to one 6-8 ounce meal per week for adults and one 2-3 ounce meal for young children.

In 2001, the U.S. Environmental Protection Agency derived a reference dose (RfD) for methyl mercury, which is a daily intake that is likely to be without appreciable risk of deleterious effects during a lifetime. This derivation used a series of benchmark dose (BMD) analyses provided by the National Research Council (NRC). Analyses were performed for a number of endpoints from all three of the longitudinal cohort studies of the neuropsychological consequences of in utero exposure to methyl mercury: the Faroe Islands, Seychelles, and New Zealand studies, as well as from the integrative analysis that NRC had undertaken. The EPA applied a total uncertainty factor (UF) of 10 for intrahuman toxicokinetic and toxicodynamic variability and uncertainty while setting this RfD. Dose conversion from cord blood mercury concentrations to maternal methyl mercury intake was performed using a one-compartment model. EPA identified cardiovascular consequences of methyl mercury exposure and delayed neurotoxicity during aging as a result of previous exposure as significant areas requiring future attention."[xxvii]

The European Commission endorsed the US EPA's reference dose as the appropriate methyl mercury standard

In October 2002, the European Commission (EC) released a report on mercury, entitled *"Ambient Air Pollution by Mercury (Hg). Position Paper."*[xxviii] The EC report identifies "exposure to methyl mercury via diet is the critical mercury problem for Europe, the reduction of potential exposure to this mercury species should be the focus for the steps to be taken in Europe...shares the recent evaluations by the US EPA and NRC (National Research Council)" and considers the US EPA's reference dose to be appropriate for Europe.

The British Food Standards Agency issued a new fish consumption advice for methyl mercury for sensitive populations based on a more protective standard

The British Food Standards Agency (FSA) began in February 2003 to advise pregnant and breastfeeding women, and women who intend to become pregnant, to limit their consumption of tuna to no more than two medium-size cans or one fresh tuna steak per week.[xxix] . The new safety guideline for pregnant and breastfeeding women and women intending to become pregnant is almost five times lower than that for the general population."[xxx]

The United Nations Environmental Programme (UNEP) recognized the critical public health importance of sharply reducing public exposures to methyl mercury.

At the United Nations Environment Programme (UNEP) Governing Council meeting in Nairobi, Kenya in February 2003, the Global Environmental Ministers endorsed the December 2002 UNEP Global Mercury Assessment Report, which recognized the serious global health threats from methyl mercury:

> "Methyl mercury is adversely affecting both humans and wildlife. This compound readily passes the placental barrier and the blood-brain barrier, and is a

neurotoxicant, which may in particular cause adverse effects on the developing brain. Studies have shown that methyl mercury in pregnant women's diets can have subtle, persistent adverse effects on children's development as observed at about the start of school age. Moreover, some studies suggest small increases in methyl mercury exposure may cause adverse effects on the cardiovascular system. Many people (and wildlife) are currently exposed at levels that pose risks of these, and possibly other adverse effects."[xxxi]

In its decision, the Governing Council agreed that "there is sufficient evidence of significant global adverse impacts from mercury and its compounds to warrant further international action to reduce the risks to human health and the environment."[xxxii] They recognized that mercury is a serious global pollutant warranting immediate action to alert the public to the exposure risks from mercury, especially vulnerable groups such as pregnant women, the fetus, the newborn and young children because of the sensitivity of the developing nervous system. The Governing Council charged UNEP with "developing strategies for enhanced outreach and risk communication activities to reach at-risk populations, including sensitive populations," affected by methyl mercury, implementing a plan to raise global awareness of the critical need to sharply reduce human exposures to mercury, and reporting on progress in implementation at the next Governing Council meeting in South Korea in 2005.[xxxiii]

CONCLUSIONS

As detailed in this paper, there is a very large body of literature on the toxic effects of exposures to low levels of methyl mercury. Three prospective epidemiological studies, in the Faroe Islands, the Seychelles, and in New Zealand, have been singled out for the development of dose response calculations, and two additional cross-sectional epidemiological studies lent weight to the analysis. These studies have looked at a wide range of endpoints, including neurological function, memory, attention, visuospatial ability, IQ, age at achieving developmental milestones, and sensory function. Other studies provide strong emerging evidence that chronic low-level methyl mercury exposure is associated with a substantially increased risk of coronary heart disease. Additional evidence developed in the past three years demonstrates that significant numbers of consumers are routinely exposed to methyl mercury doses of public health concern, primarily through their diets.

Setting aside remaining points on which the three studies of prenatal neurobehavioral toxicity appear to disagree, the weight and the convergence of evidence that methyl mercury poses a substantial threat to public health is increasingly compelling.

We urge JECFA to take stock of the literature and of the deliberations by food safety authorities that have occurred since 2000, described here and to recommend a health protective exposure limit for methyl mercury. We respectfully suggest that the science supports a lowering of the Provisional Tolerable Weekly Intake to levels

consistent with the determination by the U.S. EPA and other international bodies of an RfD no greater than 0.1 µg/kg body weight per day.

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Bill Maxwell

04/03/2003 08:48 AM

To: aberwick@mjbradley.com, aweeks@clnatf.org, bsf@vnf.com, c.mathai@pinnaclewest.com, debra.jezouit@bakerbotts.com, dennis.james@falkirk.com, dlamb1@txu.com, Dan.Weiss@Cinergy.COM, Darrel Harmon/DC/USEPA/US@EPA, Debbie Stackhouse/RTP/USEPA/US@EPA, Donald.Rose@ec.gc.ca, feeley@netl.doe.gov, grimley.william@epa.gov, hall.bob@epa.gov, hness@lignite.com, jnovak@epri.com, John Wilkins/DC/USEPA/US@EPA, llevin@epri.com, moody@wallstreetguy.com, MOpalinski@seminole-electric.com, nndharmarajan@aep.com, qshea@eei.org, scf@vnf.com, sdavis@ccap.org, tipaay@aol.com

cc:

Subject: Subgroup Meeting on April 15th

FYI.

Bill Maxwell
Combustion Group/Emission Standards Division
C439-01
U.S. EPA
Research Triangle Park, NC 27711
919-541-5430

----- Forwarded by Bill Maxwell/RTP/USEPA/US on 04/02/2003 07:49 AM -----

Sally Shaver

04/01/2003 06:05 PM

To: bbecker@sso.org, btyndall@cinergy.com, chgoodma@southernco.com, cunninghamda@coned.com, davidss@simginc.com, dschanba@tnrcc.state.tx.us, emtrisko@intrepid.net, eric.uram@sierraclub.org, frank.cassidy@pseg.com, GSchaefer@archcoal.com, jeff@jeffreysmithlaw.com, lzeugin@hunton.com, mkeating@mebtel.net, mshore@environmentaldefense.org, MRossler@eei.org, pamar@nescaum.org, paulja@rapca.org, pmraher@hhlaw.com, psilva@nrdc.org, Peter@petejonker.com, rmidulla@seminole-electric.com, robert.lacount@neg.pge.com, robert.wyman@lw.com, rwilsonnes@aol.com, stadler@nwf.org, subracom@aol.com, tnatan@environet.org, william.bumpers@bakerbotts.com, wosulliv@dep.state.nj.us, Jeff Holmstead/DC/USEPA/US@EPA

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Subject: Subgroup Meeting on April 15th

Dear Subgroup:

Unfortunately, we will not be able to complete the model runs in time for the April 15th meeting. Therefore, we will not be holding the meeting on that date. I regret any inconvenience that this may cause. We will get back to you regarding a future meeting.

Again I apologize for any inconvenience.

Sally Shaver

Bill Maxwell

04/03/2003 07:44 AM

To: MRossler@eei.org
cc: RobertJ Wayland/RTP/USEPA/US@EPA
Subject: Meeting on April 15

Michael --

I want to apologize for the relatively "late" cancellation of the Utility MACT Working Group meeting on April 15. We greatly appreciate your providing the room; we also know that you probably could use it for other purposes but have been gracious enough to "hold" it for our meetings. At this time, I have not been told of the time frame during which we might be able to try and reschedule. We'll check with you but will certainly understand if it is booked.

Thanks again.

Bill Maxwell
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November 3, 2003

Mr. Jeffery Holmstead
Assistant Administrator for Air and Radiation
U.S. Environmental Protection Agency
1200 Pennsylvania Avenue, NW
Washington, D.C. 20460

Dear Mr. Holmstead:

In August of 2001, USEPA formed a Utility MACT Working Group under the existing Permits, New Source Review, and Toxics Subcommittee of the Clean Air Act Advisory Committee (CAAAC), established under the Federal Advisory Committee Act (FACA). This working group was formed with an original constituency of six representatives of State/local/tribal agencies, eight representatives of environmental organizations, and sixteen representatives of affected sources/fuel producers and suppliers/labor groups. The working group met a total of fourteen times, and devoted many hours to the identification of issues and development of stakeholder recommendations. As co-chair of the working group, I delivered the working group's recommendations to the full CAAAC at its October 2002 meeting. One of the key recommendations of the working group was that EPA conduct runs of the Integrated Planning Model (IPM) using the stakeholder recommendations as model inputs. This recommendation was supported by the full CAAAC and approved by you at the October meeting.

Subsequent to the October presentation, the working group met for discussions in March of 2003 and scheduled a meeting for April 15, 2003 to review the results of the recommended IPM runs. Several stakeholders (Cinergy on March 26, 2003 and The Clean Energy Group on March 28, 2003) submitted specific recommendations regarding model inputs. Then, quite abruptly, EPA notified the working group on April 1, 2003 that the scheduled meeting was cancelled. There have been no further communications to the working group since the April 1 notification, although I did read a quote by Bill Wehrum in an October 25, 2003 article published in the Atlanta Journal-Constitution that, "the April 15 meeting was canceled and the advisory committee was disbanded because it had completed its work when it submitted its proposals."

On behalf of the working group, and as the working group co-chair, I request that EPA conduct the requested IPM runs and provide the results to the working group for discussion. Contrary to the statement in the Atlanta Journal-Constitution, the working group has not disbanded nor completed its work. Once EPA has conducted the IPM runs, and the working group has reviewed and discussed the results, then we will have completed our work.

Thank you for your serious consideration of this request.

Sincerely,

John A. Paul
Supervisor of RAPCA and Utility MACT Working Group Co-Chair

c: Utility MACT Working Group
Sally Shaver, Utility MACT Working Group EPA Co-chair

APPENDIX 5 – MERCURY CONTROL TECHNOLOGY DEMONSTRATION PROJECTS

SORBENT INJECTION

Facility	Rank of coal	Controls	Results[1]
Abbott	Bituminous	ACI/ESP	Baseline capture: 0% ACI capture: 73%[2]
Duke Power Cliffside	Bituminous	ACI/HS ESP	HS-ESPs have little to no instrinsic Hg removal and little to none with injected PAC[3] Baseline capture: 0%-4% B-PAC: 30-40% removal in HS-ESP's @ 5lb/Mmacf 80% Hg removal @ 6lb/MMacf possible under some conditions with B-PAC
EERC pilot-scale combustor	Lignite	Sorbent injection/CS ESP/COHPAC	Bench-scale tests results indicated that the inactivated lignite-based carbon sorbents and calcium silicate were not effective. The lignite-based carbon sorbents activated at 800oC performed significantly better than the same carbon sorbents activated at 750oC. The bench-scale testing also demonstrated the importance of hydrogen chloride in the flue gas, which apparently conditions the sorbents. The DARCO FGD and 800oC activated Luscar char-derived sorbents were selected for further pilot-scale testing. Results from the pilot-scale testing are: □The Poplar River coal had a higher mercury concentration than the Freedom coal, but both coals resulted in similar speciation with 85% elemental and 15% oxidized mercury. □Lignite coal requires a higher sorbent feed rate for similar mercury removal compared to full-scale data for bituminous coal. To achieve 70% mercury removal, the best Luscar sorbent injection rates were 17.1, 7.8, and 2.92 lb/MMacf

[1] Except where noted, the results presented here come from a recent summary of mercury control demonstration projects. *See* Department of Energy, "DOE/NETL Environmental & Water Resources Program Mercury Control Technology R&D Project Fact Sheets" (June 2003). For the most part, the results presented here are reproduced verbatim from summaries of the testing.

[2] U.S. EPA, Office of Research and Development, "Control of Mercury Emissions From Coal-Fired Electric Utility Boilers" (2004).

3 "Mercury Sorbent Results for a Hot-Side ESP at the Cliffside Plant". 2004 Electric Utility Environmental Conference. Duke Energy and Sorbent Technologies Corporation. http://www.euec.com/euec2004cd/euec2004/Master%20Presentations/EUEC%202004%20Track%20A/A5/A5d--%20Cliffside--Final.pdf

			for the ESP, FF, and combined ESP-FF configurations respectively. □Mercury removal was approximately 10 -15 percentage points higher for the Freedom coal compared to the Poplar River coal for the ESP-only configuration. □Mercury removal was approx. 10 - 15 percentage points lower for both the Freedom and Poplar River coals when the flue gas temperature was increased from 300° to 400°F for all particulate control configurations.
Great River Energy – Stanton Plant	Lignite	ACI/dry FGD/ FF	The mercury removal achieved across the SD-BH with untreated ACI was 40 to 45% at an injection concentration of 3 lb/MMacf as compared to > 90% removal with treated carbon (iodine impregnated) for the same injection rate. Thus, a SD-BH used for SO2 control on ND lignite fired units can have a detrimental effect on mercury control when untreated activated carbon is injected before the SD. Iodine impregnated carbon does not appear to be affected by the SD and was significantly more effective at removing mercury at this site. With iodine-impregnated carbon, 96% mercury removal was achieved during a short test across the SD-BH at 0.7 lb/MMacf. The average removal achieved across the SD-BH with untreated ACI was 81% at a Darco FGD injection concentration of 6.1 lb/MMacf. Although, the IAC costs > $7/lb versus nominally $0.5/lb for FGD carbon, it may be possible to use a much lower concentration of IAC than untreated carbon for this application to partially offset the higher per pound sorbent cost. The performances of three different untreated activated carbons evaluated during this program (FGD, HOK, LAC0101) were similar. The mercury removal across the baghouse is affected by the accumulation of sorbent during the cleaning cycle. At an injection concentration of nominally 6.4 lb/MMacf, the mercury removal immediately before a clean was 90% while the removal immediately following a clean was 70%. The time between cleans during testing was typically between 6 and 7 hrs.[4]
Midwest Generation Powerton Generating Station	PRB sub-bituminous	Sorbent injection/ COHPAC	The Powerton slipstream pilot testing included experimental sorbents produced from corn (CFA), oil soot (CS80), waste tires (TDAC), flyash (STI-B), a commercially available carbon made from lignite coal (HOK), and an iodine-impregnated sorbent (CB-IAC). Norit's Darco FGD activated carbon was also tested as a

[4] http://www.netl.doe.gov/publications/proceedings/02/air_q3/Apogee.pdf.

			benchmark. Major results from the Powerton pilot testing are as follows: o Initial screening tests were conducted at 1.5 lb/MMacf and 300°F using the COHPAC configuration. Similar mercury removal of approximately 80% was achieved by the FGD, CFA, CS80, and HOK sorbents. Mercury removal for the TDAC and STI-B were approximately 60% and 35% respectively. The CB-IAC mercury removal was 72% at a lower injection rate of 0.6 lb/MMacf. The CFA and HOK sorbents were selected for additional parametric testing in the COHPAC configuration based on their lower estimated delivered cost. o The parametric and long-term COHPAC testing again showed similar performance of the CFA, HOK, and FGD sorbents. However, mercury removal was different for the two types of filter bag materials that were tested. At 2 lb/MMacf the three sorbents achieved approximately 90% mercury removal with the Teflon glass bag, but only 70 - 80% mercury removal with the Torcon bag. However, the difference in mercury removal may have been a result of the bag cleaning frequency used during the testing. Mercury removal was also similar for the three sorbents at both 300° and 350° F. o Based on results of the COHPAC screening tests, the CFA and CS80 were selected for testing in the residence chamber (ESP) configuration. The FGD and IAC sorbents were also included as benchmarks. The CFA, CS80, and FGD mercury removal was less than 50% for injection rates between 2.5 and 15 lb/MMacf at both two and four second residence times. The IAC sorbent achieved approximately 60% mercury removal at four seconds and 45% at two seconds at 2.5 lb/MMacf. o Preliminary cost estimates for the alternative sorbents indicate production costs could be approximately 50% less than commercially available activated carbons.
Minnesota Power -- Laskin Energy Center	PRB	ACI/wet particulate scrubber	• Most of the vapor-phase mercury at Laskin was the elemental form. • The three untreated sorbents demonstrated poor effectiveness (< 15% mercury removal) at injection concentrations up to 12 lb/MMacf. The HOK and LAC demonstrated lower overall mercury removal than the FGD. • The activated carbon treated with iodine (CB, IAC) demonstrated improved mercury removal performance over the untreated carbons. At the highest injection concentration, 11lb/MMacf, the mercury removal across the scrubber was 54%. • The improved mercury control effectiveness

			using treated carbons may provide a potentially viable option to increase mercury removal with ACI. Further tests will be needed to determine the tradeoff of increased mercury removal versus higher sorbent costs. • Mercury measurements collected at the secondary inlet, which captured in-flight removal nominally one second downstream of sorbent injection, indicates that the mercury that is captured is captured in-flight, and some of the mercury collected by the untreated sorbents may be released in the scrubber. For the treated carbon (CB, IAC), data indicates that most of the mercury was removed by the carbon prior to entering the scrubber and the mercury concentration did not increase across the scrubber. • A very short, blended-coal test was conducted with ACI. Due to variations in the inlet mercury concentration and speciation during the blended coal test (33% bituminous, 66% PRB), no definite conclusions can be drawn regarding the effect of ACI with the blended fuel. The mercury removal across the WPS appeared to follow the level of oxidized mercury at the inlet to the scrubber. However, the removal was, at times, higher than the oxidized mercury measured.[5]
Minnesota Power -- Laskin Energy Center Unit 2	PRB	Chlorine salt injection	Tests to date show that some chemical injection can convert a significant amount of Hg to oxidized Hg. Not all oxidized Hg removed; unclear why. Scrubber caused some re-emissions. Some "fouling" of components noted; calls for additional longer-term testing.[6]
Ohio University Lausche Plant	Eastern bituminous	Sorbent injection/CS ESP	• At Lausche, the new B-PAC sorbents removed about 70% of the flue-gas mercury at a sorbent injection rate of 3 to 5 lb-per-million-cubic-feet-of-gas (lb/MMacf). The standard commercial PAC, Norit Darco FGD, removed only 18% of the mercury at 18 lb/MMacf. • If the B-PAC cost $0.65/lb in bulk quantities, the mercury removal at Lausche would cost about $9,000 per-lb-of-Hg-removed, less than 20% of DOE's current estimates of $50,000 to $70,000 per-lb-of-Hg-removed. • When the B-PAC was injected into the gas, no opacity increases from the electrostatic precipitator were observed.[7]
PG&E Brayton Point Unit 1	Bituminous	ACI/CS ESP	The PAC injection was located between the first and second cold-side ESPs. Average mercury

[5] http://www.icac.com/controlhg/MEGA03_123_Hg.pdf.

6 "Xcel Energy's Progress Report Under the Minnesota Mercury Initiative Voluntary Project," at 3-4 (Sept. 13, 2002), available online at http://www.xcelenergy.com/docs/corpcomm/MercuryAppendixC12-2_2.pdf (visited June 23, 2004).

[7] http://www.ohioairquality.org/ocdo/pdf/2004D-00-25.pdf.

			concentration at the inlet to the first ESP was approx. 6 ug/dncm of which 85% was particulate-bound. During baseline testing the average mercury removal ranged from 30 to 90% across both ESPs and 0 to 10% across the second ESP. During the parametric testing of Norit's Darco FGD activated carbon at feed rates of 3, 7, 10, 15, and 20 lb./MMacf the mercury capture averaged approx. 25%, 40%, 70%, 75%, and 90% respectively across the second ESP. The carbon injection did not deteriorate ESP performance. However, the second ESP is relatively large (400 SCA) and additional testing needs to be conducted on units with smaller ESPs.
PG&E Salem Harbor	Bituminous	ACI/CS ESP	Average mercury concentration at the inlet to the ESP was approx. 10 ug/dncm of which 95% was particulate-bound. During baseline testing without PAC injection, average mercury capture was approximately 90%. The high baseline mercury removal is attributed to high levels of unburned carbon (LOI was 25 to 30%) and low flue gas temperature (approx. 270°F). Baseline mercury removal decreased from approx. 90% to 20% while increasing flue gas temperature from 270 to 350°F. The NOx SNCR system had no effect on mercury capture. During November 2002, 4 days of long-term sorbent injection tests at 10 lb/Mmacf resulted in average capture efficiency of 94.0%[8]
PSCO Cherokee	Bituminous (Colorado)	Reverse-gas FF (Boiler Unit #3); Fly ash reinjection (LOI 7.6%)	Percent gaseous Hg removed: 98 (summer) 99 (winter)
PSCO Arapahoe	Sub-bituminous (Powder River Basin)	ESP (Boiler Unit #1); Fly ash reinjection (LOI <1 %)	Percent gaseous Hg removed: 28
PSCO Arapahoe	Sub-bituminous (PRB)	Reverse-gas FF (Boiler Unit #4); Fly ash	Percent gaseous Hg removed: 62 (summer) 82 (winter)

[8] U.S. EPA, Office of Research and Development, "Control of Mercury Emissions from Coal-Fired Electric Utility Boilers, at 5 (2004).

		reinjection (LOI 0.4%)	
PSCO Comanche	Sub-bituminous (PRB)	Reverse-gas FF (Boiler Unit #2); Fly ash reinjection (LOI 14.4%)	Percent gaseous Hg removed: 61
Southern Co. Gaston Unit 3	Bituminous	ACI/COHPAC	There was no measurable performance difference between the different PACs used during the parametric testing. Norit's Darco FGD activated carbon was used for the nine-day long-term testing. Mercury capture averaged from 87 to 90% with a carbon injection rate of 1.5 lbs/MMacf based on three short-term Ontario Hydro test results. However, the long-term mercury CEM data indicated an average capture of 78% that varied from 36% to 90%. Average COHPAC inlet mercury concentration was approx. 11 ug/dncm of which 40% was elemental. The carbon injection significantly increased the required cleaning frequency of the COHPAC baghouse. There was no improvement in mercury capture using the spray cooling system.
Southern Co. Gaston Unit 3	Bituminous	ACI/COHPAC	Preliminary baseline test results include: 1) higher COHPAC cleaning frequency compared to April 2001 Phase I tests; 2) large variation (0 to 90%) in baseline mercury removal; and 3) higher carbon content in COHPAC hopper ash compared to Phase I tests. Based on results of optimization testing, the PAC injection rate was lowered from 1.5 to 0.3 lb/MMacf. Average mercury removal varied from 70 to 95% at 0.3 lbs/MMacf PAC injection rate during early May optimization testing.
Southern Co. Yates	Bituminous	Sorbent Injection/CS-ESP/ MerCAP	Seems to have been some testing in March 2003, which indicates 85-95% total mercury removal.[9]
SRI Combustion Research Facility	Bituminous and PRB	Calcium-based sorbent/ FF	o The initial pilot-plant testing of the two proprietary calcium-based sorbents with an oxidant additive and bituminous coal showed both to be ineffective in enhancing the oxidation and capture of elemental mercury and achieved

[9] http://www.netl.doe.gov/coalpower/environment/mercury/control-tech/pubs/MerCAP%20kickoff%20mtg%20presentation-public.pdf, at 11.

			overall mercury removal of only 25 to 50%. Follow-up testing with an ordinary hydrated lime sorbent without the oxidant was able to remove 80 to 90% of the mercury which occurred primarily across the sorbent dust cake collecting on the baghouse filter bags. Approximately 30 to 35% mercury capture occurred “in-flight” prior to the baghouse. o SRI and PS Analytical developed a “spike and recovery” system to reduce mercury S-CEM measurement uncertainty. A known concentration mercury “spike” is introduced in the sampling probe in order to increase the concentration of mercury in the sampled flue gas. o Pilot-scale testing with a kaolinite ($Al_2O_3.2SiO_2.H_2O$) adsorbent and a Choctaw bituminous coal was ineffective for mercury capture at injection temperatures that ranged from 1100° to 2100°F. o SRI conducted pilot-scale testing of chlorine gas (Cl_2) injection in order to evaluate the ability of HCl to promote mercury oxidation and adsorption with PRB coal ash. Chlorine injection through the burner was effective in increasing the oxidized mercury from less than 20% to over 50% and increasing mercury adsorption on the PRB coal ash from less than 5% to over 30%. However, chlorine injection upstream of the air heater was ineffective. o SRI conducted pilot-scale testing to condition PRB coal with a high-iron, low-chlorine bituminous coal. As a result, PRB coal ash composition was found to be more important than flue gas chlorine content relative to mercury oxidation and capture. With PRB coal only, there was less than 15% oxidized mercury at the baghouse inlet. However, a coal blend with 10% bituminous and 90% PRB coal resulted in greater than 50% oxidized mercury at the baghouse inlet. o SRI also conducted tests to condition the PRB coal ash with injection of high-iron bituminous coal ash and hydrated lime at the baghouse inlet. The rate of ash/lime injection was approximately equivalent to the PRB ash loading. Three ash/lime injection ratios were tested: 100% ash; 50% ash/ 50% lime; and 20% ash/ 80% lime. The mercury oxidation across the baghouse increased from a baseline of approximately 60% to 80% with 100% high-iron bituminous ash injection. The increase in mercury oxidation was less with the ash/lime blends. o Increasing the baghouse inlet flue gas temperature from 260° to 300°F increased oxidized mercury while burning 100% PRB coal. The oxidized mercury increased less than 10

			percentage points at the baghouse inlet, but increased approximately 30 percentage points at the baghouse outlet. However, this temperature effect was not significant with the bituminous/PRB coal blend.
Wisconsin Electric -- Pleasant Prairie Unit 2	PRB sub-bituminous	ACI/CS ESP	Pleasant Prairie: Norit's Darco FGD activated carbon was used during the three 5 day long-term tests at feed rates of 1.6, 3.7, and 11.3 lb./MMacf. Mercury capture averaged approx. 46%, 57%, 73%, respectively. Average ESP inlet mercury concentration was approx. 17 ug/dncm of which 85% was elemental. The carbon injection did not deteriorate ESP performance. However, the ESP is relatively large (468 SCA) and additional testing needs to be conducted on units with smaller ESPs. There was no improvement in mercury capture using the spray cooling system.

ADDITIONAL MERCURY-SPECIFIC CONTROLS

Facility	Rank of coal	Controls	Results
Alabama Power -- Gaston Unit 4	PRB sub-bituminous	Electro Core process with PAC injection	Preliminary test results indicate the ElectroCore process captures approximately 90% of the total mercury at a PAC injection rate of 7 lb/MMacf.
ALSTOM Power	High-chlorine coal	High ratio fabric filter	In 3 tests, had removal efficiencies of 89.1, 83.1, and 49.2%. In two of the three tests the mercury removal efficiency was above 80%. In a third test the removal efficiency was significantly lower. In this test the distribution of mercury between impingers and filter differs from the two other tests. In the third test more mercury is found in the impingers, which could be a result of an increased fraction of elemental mercury. However, the conditions in the sampling train could not be directly compared with the flue gas conditions. Explanations are probably found in variations in boiler operation or variation in coal properties. High mercury removal efficiencies, >80%, is well in line with measurements from stand-alone FFs on pulverized coal fired boilers in the US firing

			Eastern bituminous coals with chlorine content in the same range as for the present case.[10]
EPA pilot-scale combustor, W.L. Gore/ARCADIS	Lignite and PRB	Pulse jet fabric filter incorporating active media	PRB: Mercury removal efficiency based on PSA (continuous) data averaged over 90% during this time period, and higher based on OH (Ontario-Hydro) data. ND Lignite: Capture efficiency during coal burning periods ranged between 70 to 96% during the entire week based on PSA data and measured 97% with duplicate Ontario-Hydro measurements taken on a single day.[11]
First Energy -- Burger	Bituminous	Electro-catalytic oxidation	Preliminary Ontario Hydro method test measurements in May 2002 resulted in an average mercury removal of 88% across the ECO pilot plant. While particulate and oxidized mercury removal exceeded 95%, there was some apparent conversion of oxidized mercury to elemental mercury which reduced the overall removal. Normal inlet flue gas elemental mercury concentration is extremely low at the Burger Plant and artificial injection of elemental mercury into the pilot plant is being tested to demonstrate ECO capability to capture elemental mercury. Mercury captured in the ECO ammonia scrubber liquid is removed using a sulfur-impregnated activated carbon filter (Mersorb). Mercury levels in the scrubber liquid have been reduced from 200 ppb to less than the limit of detection (approx. 20 ppb).
Great River Energy -- Coal Creek	Lignite	Mercury oxidation process: MerCAP	o Pilot testing for the Pd #1 and SCR catalysts began in October 2002. Oxidation of elemental mercury across Pd #1 dropped from 93% to 53% after 62 days in service. Oxidation of elemental mercury across the SCR catalyst dropped from 67% to 28% after 62 days in service. Subsequent inspection of the two catalysts indicated that a buildup of fly ash in the pilot test chamber likely caused the drop in oxidation rather than a loss of catalyst activity since mercury oxidation was restored after cleaning in January 2003. o A sonic horn is being tested to prevent the buildup of fly ash in the Pd #1 chamber and will be installed on the remaining chambers if effective. o Testing of the SBA #5 catalyst began in December 2002 and oxidation of elemental mercury was 75% when first measured in late

[10] http://www.icac.com/controlhg/MEGA03_200.pdf.
[11] http://www.icac.com/controlhg/MEGA03_232_Hg.pdf.

			January 2003. o The Carbon #6 catalyst testing is being postponed until the fly ash buildup problem is corrected. o There was some concern that the catalysts might also lead to oxidation of SO2 and NO which could produce undesirable balance-of-plant effects. However, there is no apparent oxidation of SO2 to SO3 and approximately 7% oxidation of NO to NO2.
NETL pilot-scale combustor	PRB	Activated carbon sorbent: "THIEF" process + SD/FF	The in-situ produced sorbent is not as reactive as commercially available activated carbon, but pilot-scale testing indicates that mercury removal efficiencies of up to 70% are achievable.
Otter Tail Power -- Big Stone	PRB	Advanced Hybrid Particulate Collector (AHPC)	□Results from the small pilot-scale testing burning a Belle Ayr PRB coal indicated approximately 70% of the mercury was elemental and there was very little baseline mercury capture from both the AHPC and pulse-jet baghouse. Mercury removal with the AHPC ranged from 50% to 71% at a carbon-to-mercury mass ratio of 3000:1 and from 65% to 87% at a mass ratio of 6000:1. □Results from the November 2001 short-term AHPC 2.5 MW pilot-plant test at Big Stone indicated 91 to 97% total mercury collection efficiency with a sorbent feed rate of 1.5 lb/million acf compared to a baseline (no sorbent) mercury collection efficiency of 49%. The relatively high mercury removal rates may have occurred because the average inlet mercury speciation during the testing was 55.4% particulate, 38.1% oxidized, and only 6.4% elemental. This is not considered typical for PRB coals, which normally have much higher levels of elemental mercury. Subsequent analysis showed that the high proportion of particulate and oxidized mercury may have been related to unexpectedly high levels of chlorine in the flue gas, which may have resulted from co-combustion of tire-derived fuel (TDF) in the Big Stone boiler during the November 2001 test period. □A second AHPC 2.5 MW pilot-plant test was conducted at Big Stone in August 2002 using a Belle Ayr PRB coal. Mercury speciation was 17% particulate, 32% oxidized, and 51% elemental. Baseline mercury removal ranged from 0% to 10%. Mercury removal was 63% during ACI at 1.5 lb/MMacf and without any TDF co-firing. There was no adverse effect on AHPC particulate collection performance during the ACI testing.

			□A third AHPC 2.5 MW pilot-plant test was conducted at Big Stone in November 2002. Mercury removal ranged from 65% to over 90% during ACI at 1.5 lb/MMacf and without any TDF cofiring. A possible reason for the improved mercury removal in November compared to the August 2002 test is lower flue gas temperature of 250° F compared to 270° - 290°F. Supplemental injection of HCl had little or no effect on mercury removal. □A small AHPC 200 acfm pilot-scale test was conducted in late 2002 using a Springfield high-sulfur bituminous coal. The NORIT Darco FGD activated carbon was ineffective with average mercury removal at less than 15% for various combinations of flue gas temperature (275° - 320°F) and injection rates. A possible reason for the poor mercury removal was the relatively high level of SO3 (over 30 ppm) concentration in the flue gas.

EFFECT OF SELECTIVE CATALYTIC REDUCTION & SCRUBBING ON MERCURY

Facility	Rank of coal	Controls	Results
AEP Rockport	PRB sub-bituminous	SCR catalysts for oxidation	Preliminary results from the initial mercury speciation testing are under review. Some general observations from the S-CEM measurements are: 1) mercury oxidation ranged from approx. 0% to 50% across the five catalysts at a space velocity of 5,700 hr-1, 2) mercury oxidation increased to 60% to 80% without ammonia feed, 3) an unexplained 10% to 40% reduction of total mercury was measured across the catalysts, 4) mercury oxidation decreases as space velocity increases.
Cinergy -- Zimmer	Bituminous	Enhanced wet FGD	However, the testing at Zimmer was not successful since there continued to be an increase in elemental mercury across the wet FGD system during reagent usage and there was no significant effect on total mercury removal which averaged 52% (including 87% removal of the inlet oxidized mercury) compared to a baseline removal of approximately 45%. Possible explanations for the poor results at Zimmer include the much higher sulfite concentration and lower liquid-to-gas ratio in the magnesium enhanced lime wet FGD system which may impede the reagent performance.

DOE/CONSOL et. al	Bituminous, except one site	-3 sites with SCR / SDA / Baghouse -4 sites with SCR / ESP/ wet lime FGD -3 sites with SCR / ESP / wet limestone FGD -1 site with ESP / wet limestone FGD	Site #1 (Bit-fired; SCR, SDA, baghouse): Average coal-to-stack Hg removal = 87.3% Site #2 (Bit-fired; SCR, SDA, baghouse): Average coal-to-stack Hg removal = 94.5%[12]
DOE/EPA/EPRI Multiple sites	PRB/ Bituminous	SCR plus Various technologies	o SNCR and NH3/SO3 flue gas conditioning did not affect mercury oxidation. o For the bituminous plants, the increase in oxidized mercury across the SCR varied significantly from 11 to 70 percentage points. The oxidized mercury at the downstream pollution control device (PCD) inlet, increased from -1 to 37 percentage points with an average of 17%. However, for the two sites with minimal SCR oxidation, the non-elemental mercury was greater than 90% both with and without the SCR. o SCR catalyst did not significantly promote the oxidation of mercury for the one PRB test site. The oxidized mercury increased 20 percentage points across the SCR, but was unchanged at the PCD inlet. o SCR catalysts promote mercury capture in wet FGD systems and possibly reduce the re-emission of elemental mercury. For the three plants with SCR and wet FGD, mercury removal was 84 - 92% (average 89%) with SCR operation and 43 - 51% (average 48%) without SCR operation. o SCR size, as measured by space velocity, appeared to have a minimal affect on mercury oxidation across the SCR. There was no significant difference in non-elemental mercury at the SCR outlet or PCD inlet for the five bituminous plants. o Based on results from the two plants tested in 2001 and 2002, it is uncertain whether SCR catalyst aging affects mercury oxidation. The increase in oxidized mercury across the SCR at site S2 decreased from 43 percentage points in 2001 to 33 percentage points in 2002. However, there was no change in oxidized mercury at the PCD inlet, which remained approx. 97%. The increase in oxidized mercury across the SCR at site S4 decreased from 70 percentage points in 2001 to 29 percentage points in 2002. Again,

[12] http://www.netl.doe.gov/publications/proceedings/03/mercury/Tseng.pdf.

			however, there was no change in oxidized mercury at the PCD inlet which was 93% in 2001 and 95% in 2002.
Michigan South Central Power -- Endicott Station	Bituminous	Enhanced wet FGD	The testing at Endicott was successful since there was no appreciable increase in elemental mercury across the wet FGD system during reagent usage and total mercury removal averaged 77% (including 95% removal of the inlet oxidized mercury) compared to a baseline removal of approximately 60%.

Appendix 6

CATF's Use of EPA's Benefits Transfer Method in Evaluating the Benefits of the Alternate Mercury Control Scenario

Introduction

On January 30, 2004, EPA has proposed a Utility MACT rule for mercury as well as an alternative trading program. EPA did not evaluate any alternatives to its MACT proposal. The benefits of the EPA's proposed mercury MACT limits are based on the co-benefits of reducing NOx and SO_2 emission caps, which the EPA proposed in the Interstate Air Quality Rule (IAQR). Using EPA's proposed subcategories and method for addressing emissions variability, we have calculated more stringent MACT emission rates for mercury. To evaluate the national cost and benefits of the new emission rates (the Alternate Mercury Control Scenario), the Clean Air Task Force (CATF) independently contracted ICF Consulting to estimate 2005, 2010, 2015 and 2020 power plant mercury emissions using the Integrated Planning Model (IPM) for an alternate mercury control scenario (CATF 14). The Alternate Mercury Control Scenario uses the proposed IAQR emission caps for NOx and SO_2 as the baseline scenario. The more stringent mercury emission rates result in additional SO_2 reductions beyond those calculated for the IAQR. For the Alternate Mercury Control Scenario, CATF derived SO_2 emission reductions from the IPM run and estimated health benefits using a simple transfer factor method based on an approach recently used by EPA in several recent rulemakings and other benefits analyses. We note that EPA has identified 11 health and welfare benefits associated with reducing mercury emissions, however none of these benefits has been monetized. Thus, our benefits analysis only focuses on reduced mortality associated with reductions in SO_2 emissions. If the mercury benefits were also monetized, the benefits would be far higher.

EPA has developed the simple transfer method to provide an estimate of the health damages of emissions reductions from regulatory or legislative alternatives.[1] The method is not ideal for full regulatory impact analyses, but provides useful health benefits estimates in the absence of time-consuming and prohibitively costly modeling. In EPA's words, "[t]he transfer technique used here provides reasonable approximations. Nevertheless, the method also adds uncertainty to the analysis and the results may under or overstate actual benefits of the control program."[2] The EPA approach determines health damages (in this case premature deaths) transfer factors expressed in population-adjusted damages/ton/person based on existing air quality

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[1] See Sections 10.2 and 10.3 of EPA's "Final Regulatory Support Document: Control of Emissions from Unregulated Nonroad Engines," EPA420-R-02-022, in support of its rule entitled "Control of Emissions From Nonroad Large Spark-Ignition Engines and Recreational Engines (Marine and Land-Based)," 67 Fed. Reg. 68241 (November 8, 2002), available online at http://www.epa.gov/otaq/regs/nonroad/2002/r02022k.pdf. (hereafter "Recreational Vehicle RIA").
Also see: EPA Memorandum, Bryan Hubbell to Sam Napolitano (July 2, 2001), "Estimated NOx, SO2 and PM Emissions Health Damages for Heavy Duty Vehicle Emissions.

[2] Recreational Vehicle RIA at 10-8.

modeling and attendant benefits analyses. The method also allows the approximation of monetized benefits based on health benefits for proposed initiatives.

Methodology

The transfer method as used by CATF fundamentally assumes that all $PM_{2.5}$ comes from the formation of sulfate aerosol from sulfur dioxide emissions. The estimated avoided deaths should not be viewed as benefits strictly from SO2 reductions but a combination of both SO_2 and NOx reductions. This being noted, it is reasonable to assume the majority of benefits will come from SO_2 reductions (perhaps 90% or more nationally) relative to NOx.

The following briefly describes steps in the transfer factor analysis. In short, we calculate a simple transfer factor derived from EPA IAQR modeling (avoided PM-related death benefits-per-ton of SO_2 reduced) and then apply that factor to SO_2 emissions generated by the CATF 14 IPM run as follows:

1) Modeled SO_2 for the IAQR in 2010, 2015 and 2020 (adjusted for banking and trading) were taken from EPA IAQR IPM runs.[3] Net millions of tons reduced for 2010, 2015 and 2020 were calculated by subtracting the predicted SO_2 levels for a given year from the modeled base case.[4]
2) Avoided deaths used to calculate the transfer factors were taken from the IAQR proposal technical support documents (for 2010, 9,600; for 2015, 13,000).[5]
3) To calculate the transfer factors for 2010 and 2015, avoided deaths were divided by the net SO_2 emissions reductions. Result: 2,560 and 3,403 avoided deaths per ton removed in 2010 and 2015, respectively.
4) Independent IPM SO_2 emissions in 2010, 2015 and 2020 were generated by CATF for the Alternate Mercury Control Scenario (CATF 14).
5) For the CATF 14 alternative scenario 2010, 2015 and 2020 net emissions were then multiplied times the transfer factor as follows:

IAQR Transfer factor
X
Millions of tons SO_2 reduced
X
Population Factor

[3] The SO_2 annual emissions inventories used in the calculations came from IPM modeling runs of the different scenarios as follows: IPM runs for the IAQR came from the U.S. EPA web site at http://www.epa.gov/airmarkets/epa-ipm/iaqr.html. The IPM runs for the Alternate Mercury Control Scenario were run for the Clean Air Task Force by ICF.
[4] Base case is same as for Clear Skies (2003) and assumes full implementation of Title IV of the CAA but does not include other additional SO_2 reductions requirements, e.g. PM2.5, regional haze, or BART implementation.
[5] Health benefits are documented in EPA's technical support document: " Benefits of the Proposed Interstate Air Quality Rule." Available at: http://www.epa.gov/air/interstateairquality/tsd0175.pdf

6) A population factor is multiplied times the result to account for population growth. In this analysis population adjustment is unnecessary since the modeling is already based on the projected populations for 2010, 2015 and 2020.

The data used to derive the transfer factors are summarized in the following table:

SUMMARY OF EPA REMSAD DATA UTILIZED FOR MORTALITY TRANSFER FACTORS ESTIMATES

	SO_2 Nominal Cap (Million TPY)	**IPM EGU SO_2 Emissions (Million TPY)**	**Net SO_2 Reduction (Million TPY)**	**Mortality Reduction from Base (from IAQR)**	***FACTOR * Mortality Reduction Per million TPY SO_2**
Base 2010		9.9			
IAQR 2010	3.9	6.1	3.8	9,600	2,560
Base 2015		9.2			
IAQR 2015	2.7	5.4	3.8	13,000	3,403
IAQR 2020		4.3			
CATF (14) Alternative, 2010		4.1	2		
CATF (14) Alternative, 2015		4.1	1.3		
CATF (14) Alternative, 2020		4.0	0.3		

RESULTS

Incremental estimated PM-related avoided deaths and monetized benefits for the Alternate Mercury Control Scenario are summarized below.

Incremental Avoided PM-Related Deaths from Alternate Mercury Control Scenario (Proposed IAQR is Baseline)

Alternate Mercury Control Scenario	**2010**	**2015**	**2020**
Avoided Deaths	5,191	4,465	1,096
Avoided Deaths Benefit (1999 dollars)	$28 billion	$26.3 billion	$6.9 billion

Appendix 7

Summary of Integrated Planning Model Results for the Alternate Mercury Control Scenario (CATF 14b)

Cost Summary for CATF 14b (Million $)

	2005	2010	2015	2020
Total Cost Electricity Production	77005	94136	103172	115665

Allowance Price for CATF14b ($/Ton)

	2005	2010	2015	2020
SO2 Title IV	0	0	0	0
PM SO2 Constraint (28 States Plus DC)	0	808	1048	1359
NOx SIPCall & PM (28 States Plus DC)	2120	531	688	893
National MER ($/Lb)	0	0	0	0
CO2	0	0	0	0

Air Emissions for CATF14b

	2005	2010	2015	2020
SO2 [Thousand Tons]	11560	4083	4093	4018
NOX [Thousand Tons]	3793	2195	2256	2284
CO2 [Million Tonnes]	2204	2366	2505	2640
Carbon [Million Tonnes]	601	645	683	720
MER - Coal [Tons]	46	12	12	12

Fuel Consumption for CATF14b (TBtu)

	2005	2010	2015	2020
Coal	20561	21141	21444	21529
Oil	0	11	0	0
Gas	5014	7111	9213	11606
Biomass	106	110	113	114

Delivered Fuel Prices for CATF14b ($/MMBtu)

	2005	2010	2015	2020
Coal	1.16	1.07	1.02	0.96
Oil	0	3.35	0.00	0.00
Gas	2.96	3.21	3.08	2.99
Biomass	1.43	1.47	1.47	1.47

Wholesale Electric Prices for CATF14b (mills/kWh)

	2005	2010	2015	2020
National	23.15	27.85	35.29	37.59

Total Generation for CATF 14b
(GWh)

UnitType		2005	2010	2015	2020
Scrubbed Coal_NOx	1	199267	174260	174290	174290
Scrubbed Coal	2	409486	129875	127534	123935
Unscrubbed Coal_NOx	3	347044	6492	5275	1141
Unscrubbed Coal	4	835820	78438	77817	76368
Oil/Gas Steam	5	44971	66151	39582	27316
Oil/Gas Steam_Nox	6	1482	2747	3443	1879
Nuclear	7	785779	790910	792019	786984
Hydro	8	269380	269380	269380	269380
Comb.Cycle Gas	9	475671	629983	854903	1163790
IGCC	10	4702	4702	4702	4702
Turbine	11	19341	35015	66768	103909
Biomass	12	8886	9358	9777	10120
Geothermal	13	22429	23518	24571	24571
Landfill Gas	14	3958	5206	6609	7694
Wind	15	14310	16026	17327	18271
Fuel Cell	16	12	29	52	66
Solar	17	886	892	892	892
Non Fossil_Other	18	17936	17936	17936	17936
Fossil_Other	19	985	985	985	985
Pump Storage	20	9469	10539	11071	8628
Int. Imports	21	44616	28078	21538	22657
Cgn_Coal	22	27489	3950	3950	3950
Cgn_Gas	23	89337	125633	152936	160466
Cgn_Oil	24	3162	4578	2894	2894
Cgn_Other	25	7158	7112	7050	7180
NonCG IPP_Coal	26	0	0	0	0
NonCG IPP_Gas	27	0	0	0	0
NonCG IPP_Other	28	0	0	0	0
Blr_Coal	29	0	0	0	0
Blr_Gas	30	0	0	0	0
Blr_Oil	31	0	0	0	0
Blr_Other	32	0	0	0	0
SteamOnly Cogen	33	0	0	0	0
Rep.Coal-CC	34	0	1465	4229	4157
Rep.O/G-CC	35	0	34490	58327	58767
Rep.Coal-IGCC	36	0	0	0	0
Ret.Scrubber	37	584	15540	15540	17946
Ret.ExistSCR & Scrub	38	0	248587	252072	256471
Ret.ExistSNCR & Scrub	39	0	1312	1312	1312
Ret.SCR	40	151900	5331	4073	3848
Ret.ExistScrub & SCR	41	96370	203665	206925	210754
Ret.SNCR	42	0	0	0	0
Ret.ExistScrub & SNCR	43	0	0	0	0
Ret.SCR+Scrb	44	1298	519280	531408	534849
Ret.SNCR+Scrub	45	0	0	0	0

Ret.Gas Reburn	46	0	0	0	0
Ret.ExistScrub+GasR	47	0	0	0	0
Ret.GasReburn+Scrub	48	0	0	0	0
Ret.ACI	49	0	327540	339616	341437
Ret.ExistScrub&ACI	50	0	179450	181053	181964
Ret.ExistSCR&ACI	51	0	33744	33744	33744
Ret.ExistSNCR&ACI	52	0	20477	20919	20657
Ret.ACI & SCR	53	0	26793	26318	26570
Ret.ExistScrub&ACI&SCR	54	0	2339	2574	2603
Ret.ACI & SNCR	55	0	0	0	0
Ret.ExistScrub&ACI&SNCR	56	0	34	34	38
Ret.ACI & Srub	57	0	65047	65110	65365
Ret.ExistSCR&ACI&Scrub	58	0	4263	4593	4593
Ret.ExistSNCR&ACI&Scrub	59	0	23299	24232	24232
Ret.ExistSNCR&ExistScrub&ACI	60	0	4606	4634	4885
Ret.ExistSCR&ExistScrub&ACI	61	0	21290	21987	21987
Ret.ExistNOx&ExistScrub&ACI	62	0	1963	2094	2256
Ret.SCR & Scrub & ACI	63	0	11662	11664	11896
Ret.SNCR & Scrub & ACI	64	0	0	0	0
Ret.O/G SCR	65	0	0	0	0
Ret.O/G SNCR	66	0	768	687	255
Ret.Nuclear (age 30+10 yrs)	67	0	0	0	0
Ret.Nuclear (age 40+20 yrs)	68	0	0	0	0
Ret. Biomass Cofiring	69	0	0	0	0
CT Early Retirement	70	0	0	0	0
CC Early Retirement	71	0	0	0	0
O/G Early Retirement	72	0	0	0	0
Coal Early Retirement	73	0	0	0	0
Nuke Early Retirement	74	0	0	0	0

Note: Ret. ==> Retrofit of existing capacity, Rep. ==> Repowering of existing capacity.

Total Capacity for CATF14b (MW)

UnitType		2005	2010	2015	2020
Scrubbed Coal_NOx	1	27267	23411	23406	23406
Scrubbed Coal	2	58317	18717	18694	18591
Unscrubbed Coal_NOx	3	48804	1427	1016	418
Unscrubbed Coal	4	126291	14745	12933	11997
Oil/Gas Steam	5	93361	92972	91467	91467
Oil/Gas Steam_Nox	6	7720	5689	5689	5689
Nuclear	7	99087	99289	99480	99594
Hydro	8	89869	89869	89869	89869
Comb.Cycle Gas	9	133549	135917	151346	189004
IGCC	10	612	612	612	612
Turbine	11	130557	131472	144151	174185
Biomass	12	1347	1404	1472	1511
Geothermal	13	2943	3086	3223	3223
Landfill Gas	14	502	670	858	1004
Wind	15	5078	5702	6159	6488
Fuel Cell	16	17	17	17	17
Solar	17	413	416	416	416
Non Fossil_Other	18	2275	2275	2275	2275
Fossil_Other	19	125	125	125	125
Pump Storage	20	22854	22854	22854	22854
Int. Imports	21	11000	11000	11000	11000
Cgn_Coal	22	3992	660	660	660
Cgn_Gas	23	42570	42570	42570	42570
Cgn_Oil	24	1069	1069	1069	1041
Cgn_Other	25	1075	1075	1075	1075
NonCG IPP_Coal	26	0	0	0	0
NonCG IPP_Gas	27	0	0	0	0
NonCG IPP_Other	28	0	0	0	0
Blr_Coal	29	0	0	0	0
Blr_Gas	30	0	0	0	0
Blr_Oil	31	0	0	0	0
Blr_Other	32	0	0	0	0
SteamOnly Cogen	33	0	0	0	0
Rep.Coal-CC	34	0	266	672	672
Rep.O/G-CC	35	0	4355	7365	7420
Rep.Coal-IGCC	36	0	0	0	0
Ret.Scrubber	37	78	2137	2137	2460
Ret.ExistSCR & Scrub	38	0	33494	33857	34443
Ret.ExistSNCR & Scrub	39	0	176	176	176
Ret.SCR	40	21505	1467	1472	1564
Ret.ExistScrub & SCR	41	13202	28379	28347	28433
Ret.SNCR	42	0	0	0	0
Ret.ExistScrub & SNCR	43	0	0	0	0
Ret.SCR+Scrb	44	174	70196	71407	71846
Ret.SNCR+Scrub	45	0	0	0	0
Ret.Gas Reburn	46	0	0	0	0

Ret.ExistScrub+GasR	47	0	0	0	0
Ret.GasReburn+Scrub	48	0	0	0	0
Ret.ACI	49	0	47523	47892	47918
Ret.ExistScrub&ACI	50	0	24420	24444	24457
Ret.ExistSCR&ACI	51	0	4532	4532	4532
Ret.ExistSNCR&ACI	52	0	3019	3019	3019
Ret.ACI & SCR	53	0	3900	3929	3937
Ret.ExistScrub&ACI&SCR	54	0	314	346	350
Ret.ACI & SNCR	55	0	0	0	0
Ret.ExistScrub&ACI&SNCR	56	0	6	6	6
Ret.ACI & Srub	57	0	8770	8778	8778
Ret.ExistSCR&ACI&Scrub	58	0	617	617	617
Ret.ExistSNCR&ACI&Scrub	59	0	3254	3254	3254
Ret.ExistSNCR&ExistScrub&ACI	60	0	657	657	657
Ret.ExistSCR&ExistScrub&ACI	61	0	2948	2953	2953
Ret.ExistNOx&ExistScrub&ACI	62	0	303	303	303
Ret.SCR & Scrub & ACI	63	0	1566	1566	1598
Ret.SNCR & Scrub & ACI	64	0	0	0	0
Ret.O/G SCR	65	0	0	0	0
Ret.O/G SNCR	66	0	242	242	242
Ret.Nuclear (age 30+10 yrs)	67	0	0	0	0
Ret.Nuclear (age 40+20 yrs)	68	0	0	0	0
Ret. Biomass Cofiring	69	0	0	0	0
CT Early Retirement	70	278	278	278	278
CC Early Retirement	71	1213	1213	1213	1213
O/G Early Retirement	72	29548	29548	29548	29548
Coal Early Retirement	73	6545	6833	6833	6833
Nuke Early Retirement	74	0	0	0	0

Note: Ret. ==> Retrofit of existing capacity, Rep. ==> Repowering of existing capacity.

CATF14b - Emissions by NERC Region				
Year	**NERC Region**	**SO2 [Thousand Tons]**	**NOX [Thousand Tons]**	**MER - Coal [Tons]**
2005	ECAR	4083.9	933.8	11.6
	ERCOT	398.7	146.7	2.5
	FRCC	264.3	185.1	0.9
	MAAC	895.0	206.9	5.4
	MAIN	1064.4	297.7	3.5
	MAPP	677.7	311.7	3.7
	NPCC	361.3	92.7	1.8
	SERC	3059.7	840.4	10.3
	SPP	428.5	255.8	3.7
	WSCC	326.9	522.2	3.0
2005 Total		**11560.4**	**3793.0**	**46.5**
2010	ECAR	1018.1	342.4	2.7
	ERCOT	249.1	165.8	1.5
	FRCC	123.9	49.5	0.3
	MAAC	142.6	69.1	1.2
	MAIN	418.5	158.9	1.0
	MAPP	565.6	284.7	1.5
	NPCC	111.9	66.5	0.4
	SERC	816.0	340.1	1.8
	SPP	311.3	182.8	1.0
	WSCC	326.3	534.8	1.0
2010 Total		**4083.2**	**2194.6**	**12.4**
2015	ECAR	1040.0	361.0	2.7
	ERCOT	236.3	160.9	1.5
	FRCC	123.7	55.2	0.3
	MAAC	143.9	74.0	1.2
	MAIN	428.4	166.5	1.0
	MAPP	576.7	289.4	1.6
	NPCC	101.3	66.4	0.4
	SERC	819.8	356.3	1.8
	SPP	298.9	185.1	0.9
	WSCC	324.0	541.3	1.0
2015 Total		**4093.1**	**2256.1**	**12.3**
2020	ECAR	1002.6	372.4	2.7
	ERCOT	220.6	154.4	1.5
	FRCC	125.0	51.6	0.3

	MAAC	141.7	76.4	1.1
	MAIN	433.5	175.4	1.1
	MAPP	584.2	291.5	1.6
	NPCC	99.0	66.5	0.4
	SERC	792.4	363.4	1.7
	SPP	294.7	187.4	0.9
	WSCC	324.3	544.9	1.0
2020 Total		**4017.9**	**2283.9**	**12.2**

Summary of Integrated Planning Model Results for IAQR + EPA MACT Regulatory Scenario (CATF 20)

Cost Summary for CATF20 (Million $)

	2005	2010	2015	2020
Total Cost	76911	91399	101602	115016

Allowance Price for CATF20 ($/Ton)

	2005	2010	2015	2020
SO2 Title IV	0	0	0	0
PM SO2 Constraint (28 States Plus DC)	0	958	1243	1450
NOx SIPCall & PM (28 States Plus DC)	2103	1023	1326	1426
National MER ($/Lb)	0	0	0	0
CO2	0	0	0	0

Air Emissions for CATF20

	2005	2010	2015	2020
SO2 [Thousand Tons]	11626	4806	4189	3655
NOX [Thousand Tons]	3802	2444	2282	2181
CO2 [Million Tonnes]	2207	2363	2502	2639
Carbon [Million Tonnes]	602	645	682	720
MER - Coal [Tons]	46	26	25	23

Fuel Consumption for CATF20 (TBtu)

	2005	2010	2015	2020
Coal	20613	21091	21360	21501
Oil	0	8	0	0
Gas	4982	7111	9259	11627
Biomass	106	110	113	114

Delivered Fuel Prices for CATF20 ($/MMBtu)

	2005	2010	2015	2020
Coal	1.16	1.08	1.02	0.96
Oil	0	3.35	0.00	0.00
Gas	2.93	3.19	3.08	3.00
Biomass	1.42	1.47	1.47	1.47

Wholesale Electric Prices for CATF20 (mills/kWh)

	2005	2010	2015	2020
National	22.95	27.95	35.36	37.70

CATF 20

Region Coal Production by year (MMBtu)

Coal Region	2005	2010	2015	2020
Appalachia	7973	7828	7986	7758
Interior	3466	4234	4603	4804
West	9174	9029	8770	8939
National	20613	21091	21360	21501

Region Coal Production by year (Million Ton)

Coal Region	2005	2010	2015	2020
Appalachia	320	315	321	311
Interior	178	212	228	235
West	489	476	465	468
National	987	1003	1014	1014

Coal Consumption by rank (TBtu)

	2005	2010	2015	2020
Bituminous	14109.3	15053.1	15366.7	15985.1
Subbituminous	5552.7	5094.1	5075.8	4645.4
Lignite	951	943.8	917.3	870

Henry Hub Gas Prices [US$/MMBtu]

2005	2010	2015	2020
2.87	3.13	3.01	2.93

Minemouth Coal Prices by year (1999$/MMBtu)

Coal Region	2005	2010	2015	2020
Appalachia	0.91	0.83	0.8	0.77
Interior	0.81	0.72	0.67	0.64
West	0.38	0.38	0.36	0.36
National	0.66	0.62	0.59	0.57

Minemouth Coal Prices by year (1999$/Ton)

Coal Region	2005	2010	2015	2020
Appalachia	22.62	20.68	19.87	19.24
Interior	15.67	14.31	13.53	13
West	7.16	7.25	6.83	6.89
National	13.71	12.96	12.46	12.09

Total Generation for CATF20 (GWh)

UnitType		2005	2010	2015	2020
Scrubbed Coal_NOx	1	199050	189105	188767	188912
Scrubbed Coal	2	427742	327923	291366	285581
Unscrubbed Coal_NOx	3	347688	88590	56349	20722
Unscrubbed Coal	4	822677	451655	361616	278793
Oil/Gas Steam	5	41937	48440	26708	19980
Oil/Gas Steam_Nox	6	1482	2761	3432	1908
Nuclear	7	785779	790910	792019	786984
Hydro	8	269380	269380	269380	269380
Comb.Cycle Gas	9	472000	631704	866067	1179685
IGCC	10	4702	4702	4702	4702
Turbine	11	19526	34594	65153	99119
Biomass	12	8886	9363	9873	10120
Geothermal	13	22429	23518	24571	24571
Landfill Gas	14	3958	5206	6609	7694
Wind	15	14310	16026	17327	18271
Fuel Cell	16	12	29	67	66
Solar	17	886	892	892	892
Non Fossil_Other	18	17936	17936	17936	17936
Fossil_Other	19	985	662	662	662
Pump Storage	20	9505	9181	10799	8591
Int. Imports	21	44616	28078	21538	22657
Cgn_Coal	22	27489	15217	12951	13040
Cgn_Gas	23	91394	127084	154260	156929
Cgn_Oil	24	3162	4109	2894	2894
Cgn_Other	25	7158	7118	7002	7180
NonCG IPP_Coal	26	0	0	0	0
NonCG IPP_Gas	27	0	0	0	0
NonCG IPP_Other	28	0	0	0	0
Blr_Coal	29	0	0	0	0
Blr_Gas	30	0	0	0	0
Blr_Oil	31	0	0	0	0
Blr_Other	32	0	0	0	0
SteamOnly Cogen	33	0	0	0	0
Rep.Coal-CC	34	0	1604	1658	1792
Rep.O/G-CC	35	0	34641	58439	58757
Rep.Coal-IGCC	36	0	0	0	0
Ret.Scrubber	37	584	119992	125165	119961
Ret.ExistSCR & Scrub	38	0	215387	245102	276789
Ret.ExistSNCR & Scrub	39	0	21771	24336	28565
Ret.SCR	40	170289	83122	67577	62883
Ret.ExistScrub & SCR	41	76761	163462	198975	202533
Ret.SNCR	42	161	0	2854	4435
Ret.ExistScrub & SNCR	43	0	0	615	1259
Ret.SCR+Scrb	44	1298	310892	429831	519506
Ret.SNCR+Scrub	45	0	0	0	0
Ret.Gas Reburn	46	0	0	0	0

Ret.ExistScrub+GasR	47	0	0	0	0
Ret.GasReburn+Scrub	48	0	0	0	0
Ret.ACI	49	0	43927	44375	44174
Ret.ExistScrub&ACI	50	0	24766	25486	25794
Ret.ExistSCR&ACI	51	0	5110	5110	5110
Ret.ExistSNCR&ACI	52	0	4519	4410	4290
Ret.ACI & SCR	53	0	6051	6060	6127
Ret.ExistScrub&ACI&SCR	54	0	0	0	0
Ret.ACI & SNCR	55	0	274	269	364
Ret.ExistScrub&ACI&SNCR	56	0	718	1527	1621
Ret.ACI & Srub	57	0	2209	2209	2209
Ret.ExistSCR&ACI&Scrub	58	0	2676	2676	2676
Ret.ExistSNCR&ACI&Scrub	59	0	7949	8537	8627
Ret.ExistSNCR&ExistScrub&ACI	60	0	1531	2085	2156
Ret.ExistSCR&ExistScrub&ACI	61	0	10083	10733	10733
Ret.ExistNOx&ExistScrub&ACI	62	0	985	1040	1131
Ret.SCR & Scrub & ACI	63	0	10583	11551	24899
Ret.SNCR & Scrub & ACI	64	0	0	0	0
Ret.O/G SCR	65	0	3906	3497	1298
Ret.O/G SNCR	66	0	12401	8843	5566
Ret.Nuclear (age 30+10 yrs)	67	0	0	0	0
Ret.Nuclear (age 40+20 yrs)	68	0	0	0	0
Ret. Biomass Cofiring	69	0	0	0	0
CT Early Retirement	70	0	0	0	0
CC Early Retirement	71	0	0	0	0
O/G Early Retirement	72	0	0	0	0
Coal Early Retirement	73	0	0	0	0
Nuke Early Retirement	74	0	0	0	0

Note: Ret. ==> Retrofit of existing capacity, Rep. ==> Repowering of existing capacity.

Total Capacity for CATF20 (MW)

UnitType	2005	2010	2015	2020
Scrubbed Coal_NOx 1	27267	25466	25388	25386
Scrubbed Coal 2	61097	45902	40973	40539
Unscrubbed Coal_NOx 3	48967	13030	8169	3281
Unscrubbed Coal 4	124955	69938	54978	42203
Oil/Gas Steam 5	92708	86060	84558	84558
Oil/Gas Steam_Nox 6	7720	5669	5669	5669
Nuclear 7	99087	99289	99480	99594
Hydro 8	89869	89869	89869	89869
Comb.Cycle Gas 9	133549	135995	152107	191053
IGCC 10	612	612	612	612
Turbine 11	130608	131572	142997	171752
Biomass 12	1347	1404	1472	1511
Geothermal 13	2943	3086	3223	3223
Landfill Gas 14	502	670	858	1004
Wind 15	5078	5702	6159	6488
Fuel Cell 16	17	17	17	17
Solar 17	413	416	416	416
Non Fossil_Other 18	2275	2275	2275	2275
Fossil_Other 19	125	125	125	125
Pump Storage 20	22854	22854	22854	22854
Int. Imports 21	11000	11000	11000	11000
Cgn_Coal 22	3992	2279	1948	1934
Cgn_Gas 23	42570	42570	42570	42570
Cgn_Oil 24	1069	1069	1069	1049
Cgn_Other 25	1075	1075	1075	1075
NonCG IPP_Coal 26	0	0	0	0
NonCG IPP_Gas 27	0	0	0	0
NonCG IPP_Other 28	0	0	0	0
Blr_Coal 29	0	0	0	0
Blr_Gas 30	0	0	0	0
Blr_Oil 31	0	0	0	0
Blr_Other 32	0	0	0	0
SteamOnly Cogen 33	0	0	0	0
Rep.Coal-CC 34	0	202	209	226
Rep.O/G-CC 35	0	4374	7379	7419
Rep.Coal-IGCC 36	0	0	0	0
Ret.Scrubber 37	78	16128	16831	16111
Ret.ExistSCR & Scrub 38	0	28958	32935	37171
Ret.ExistSNCR & Scrub 39	0	2983	3308	3836
Ret.SCR 40	24050	13040	10885	9944
Ret.ExistScrub & SCR 41	10568	22326	26990	27311
Ret.SNCR 42	26	0	546	794
Ret.ExistScrub & SNCR 43	0	0	104	186
Ret.SCR+Scrb 44	174	41766	57737	69780
Ret.SNCR+Scrub 45	0	0	0	0
Ret.Gas Reburn 46	0	0	0	0

Ret.ExistScrub+GasR	47	0	0	0	0
Ret.GasReburn+Scrub	48	0	0	0	0
Ret.ACI	49	0	6132	6247	6316
Ret.ExistScrub&ACI	50	0	3394	3441	3470
Ret.ExistSCR&ACI	51	0	686	686	686
Ret.ExistSNCR&ACI	52	0	640	640	640
Ret.ACI & SCR	53	0	817	818	824
Ret.ExistScrub&ACI&SCR	54	0	0	0	0
Ret.ACI & SNCR	55	0	41	41	53
Ret.ExistScrub&ACI&SNCR	56	0	106	221	223
Ret.ACI & Srub	57	0	297	297	297
Ret.ExistSCR&ACI&Scrub	58	0	359	359	359
Ret.ExistSNCR&ACI&Scrub	59	0	1067	1147	1159
Ret.ExistSNCR&ExistScrub&ACI	60	0	219	290	290
Ret.ExistSCR&ExistScrub&ACI	61	0	1441	1441	1441
Ret.ExistNOx&ExistScrub&ACI	62	0	142	151	152
Ret.SCR & Scrub & ACI	63	0	1421	1551	3344
Ret.SNCR & Scrub & ACI	64	0	0	0	0
Ret.O/G SCR	65	0	1231	1231	1231
Ret.O/G SNCR	66	0	5280	5280	5280
Ret.Nuclear (age 30+10 yrs)	67	0	0	0	0
Ret.Nuclear (age 40+20 yrs)	68	0	0	0	0
Ret. Biomass Cofiring	69	0	0	0	0
CT Early Retirement	70	227	227	227	227
CC Early Retirement	71	1213	1213	1213	1213
O/G Early Retirement	72	30201	30201	30201	30201
Coal Early Retirement	73	4999	5507	5507	5507
Nuke Early Retirement	74	0	0	0	0

Note: Ret. ==> Retrofit of existing capacity, Rep. ==> Repowering of existing capacity.

Bill Maxwell

09/26/2003 10:42 AM

To: Stephen.Becker@paconsulting.com
cc: Teresa Clemons/RTP/USEPA/US@EPA, Jim Eddinger/RTP/USEPA/US@EPA, Sims Roy/RTP/USEPA/US@EPA
Subject: Re: MACT Standards for Power Plants

Mr. Becker --

MACT standards for oil- and coal-fired electric utility steam generating units will be proposed on or before December 15, 2003. These HAP standards will address all HAP -- including mercury -- from these sources. Sources will be required to comply with the standards through whatever means they deem appropriate -- doing nothing (if they are already emitting below the level of the standards), adding controls, switching or blending fuels, etc. However, other than "bubbling" of emissions at a given facility, the MACT does not provide for a "cap-and-trade" approach.

Bill Maxwell
Combustion Group/Emission Standards Division
C439-01
U.S. EPA
Research Triangle Park, NC 27711
919-541-5430

Stephen Becker <Stephen.Becker@paconsulting.com>

09/25/2003 10:45 AM

To: Sims Roy/RTP/USEPA/US@EPA
cc:
Subject: MACT Standards for Power Plants

Sims,

I left you a voicemail earlier concerning MACT standards for mercury emitting power plants. Can you tell me if the December 15, 2003 regulation is going to regulated power plants that emit mercury? If so, will they be required to retrofit mercury control technology or will there be a cap-and-trade program?

Thanks for your help.
Steve

Stephen Becker
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A SYSTEM-WIDE COMPLIANCE ALTERNATIVE FOR MERCURY EMISSIONS FROM ELECTRIC UTILITY STEAM GENERATING UNITS – LEGAL AND POLICY BASIS

September 4, 2003

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TABLE OF CONTENTS

A SYSTEM-WIDE COMPLIANCE ALTERNATIVE FOR MERCURY EMISSIONS FROM ELECTRIC UTILITY STEAM GENERATING UNITS – LEGAL AND POLICY BASIS

A. Introduction

On December 20, 2000, EPA issued a Regulatory Finding under § 112(n)(1)(A) of the Clean Air Act ("CAA") that regulation of HAP emissions from coal-fired electric utility steam generating units under § 112 is appropriate and necessary. 65 Fed. Reg. 79825 ("Regulatory Finding"). Specifically, EPA determined that it is appropriate and necessary to regulate mercury emissions from coal-fired units due to the potential hazards associated with human exposure to mercury emissions. [1]

This white paper addresses the question of whether EPA has the authority under the CAA to implement a system-wide or pooled performance standard pursuant to its regulation of mercury emissions from electric utility steam generating units. [2] It concludes that EPA does have such authority because EPA's authority to regulate mercury emissions from power plants derives from § 112(n)(1)(A), not § 112(d). Unlike § 112(d), EPA's regulation under the distinct framework of § 112(n)(1)(A) is risk-based. Under § 112(n)(1)(A), EPA may implement a system-wide or pooled performance standard so long as the relevant standard addresses the risk of harm § 112(n) was intended to ameliorate. The white paper further concludes that, because health risks associated with mercury emissions from power plants are uniquely global rather than local, unit-specific or facility-specific reductions are not necessary to address any risks that may be associated with power plant mercury emissions. Finally, the white paper concludes that public policy favors the implementation a system-wide standard. Emissions averaging in other contexts has resulted in greater compliance and environmental benefits at lower costs. Additionally, such programs have demonstrated that geographic shifts in emissions do not result, suggesting that a system-wide standard for mercury will not create problems with hot spots. Rather, a system-wide performance standard would afford affected sources the flexibility to find the best and cheapest methods of compliance, and will achieve the desired environmental benefits while lowering the cost of emissions reduction.

B. EPA's Authority To Regulate Mercury Emissions From Power Plants Derives From CAA § 112(n), Not § 112(d), And § 112(n) Permits The Implementation Of A System-Wide Performance Standard

Section 112(n)(1)(A) of the CAA provides that EPA is to regulate HAP emissions from electric utility steam generating units only if EPA determines that such regulation is "appropriate and necessary" following a study of the health impacts of HAP emissions from such units. EPA's authority to regulate HAP emissions from electricity generators is contained in its entirety in CAA § 112(n)(1)(A),[3] which states:

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1 65 Fed. Reg. 79825, 79828.

2 The rationale described herein would also allow for an inter-facility trading compliance alternative.

3 42 U.S.C. § 7412(n)(1)(A) (2003).

> The Administrator shall perform a study of the hazards to public health reasonably anticipated to occur as a result of emissions by electric utility steam generating units of pollutants listed under subsection (b) of this section after imposition of the requirements of this chapter. The Administrator shall report the results of this study to the Congress within 3 years after November 15, 1990. The Administrator shall develop and describe in the Administrator's report to Congress alternative control strategies for emissions which may warrant regulation under this section. The Administrator shall regulate electric utility steam generating units under this section, if the Administrator finds such regulation is appropriate and necessary after considering the results of the study required by this subparagraph.

42 U.S.C. § 7412(n)(1)(A).

In accordance with its statutory mandate, EPA issued its Regulatory Finding under § 112(n)(1)(A) on December 20, 2000 which concluded that it is appropriate and necessary to regulate HAP emissions from electricity generators due to hazards to public health attributable to emissions of mercury from coal-fired units.[4] EPA's Regulatory Finding, therefore, establishes the factual predicate for EPA's regulation under § 112(n)(1)(A) of mercury emissions from coal-fired units.

1. Unlike Regulation Pursuant To § 112(d), EPA's Regulation Of Mercury Emissions Under The Distinct Framework of § 112(n) Is Risk-Based And, Therefore, Must Address Health Risks Posed By Mercury Emissions From Power Plants.

EPA derives its authority to regulate power plant mercury emissions from CAA § 112(n), rather than § 112(d). The distinction is significant because § 112(n) sets very different standards for regulation than § 112(d) does. Section 112(n)(1)(A) prescribes a selective and purely risk-based protocol for the regulation of power plant HAP emissions. This approach is based on Congress's recognition that electricity generator emissions already are regulated to a great extent under other provisions of the CAA. Indeed, in § 112(n)(1)(A), Congress instructed EPA to regulate HAP emissions from power plants only to the extent that they pose a health risk *after* imposition of other requirements of the CAA. In contrast, the benchmark for EPA's standard setting under § 112(d) is the emissions limitation achieved by the best controlled similar source (with respect to new sources) or the best controlled 12 percent of similar sources (with respect to existing sources).[5] Thus, while § 112(d) creates a rebuttable presumption of regulation based on the emissions performance of the best-controlled

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4 65 Fed. Reg. at 79828. For purposes of analysis, industry assumes, without conceding, that EPA validly determined that regulation of mercury emissions from power plants is appropriate and necessary.

5 42 U.S.C. § 7412(d)(3).

sources in the category or subcategory,[6] § 112(n) calls for selective regulation of power plant HAP emissions premised entirely on a finding of he alth risk.

This distinction is particularly apparent in § 112(n)' s "appropriate and necessary" language, for which § 112(d) contains no analogue. While § 112(d) calls for regulation of all major sources of HAPs[7] based on the emissions limitation achiev ed by similar sources, § 112(n) calls for regulation of power plant HAP emissions only insofar as it is "appropriate and necessary after considering the results of the study [of health risk] required by this subparagraph," even though virtually all power plants are "major sources." Congress provided a distinct regulatory mandate for power plant HAPs "because of the logic of basing any decision to regulate on the results of scientific study and because of the emission reductions that will be achieved and th e extremely high costs that electricity generators will face under other provisions of the new Clean Air Act amendments." [8]

That Congress intended EPA to regulate HAP emissions under § 112(n) independently of § 112(d) is further evidenced by § 112(n)' s provision for EPA to develop alternative control strategies. In § 112(n), Congress charged the Administrator with developing and reporting alternative control strategies for ameliorating hazards to the public health that the Administrator determines are rea sonably anticipated to occur as a result of emissions by electric utility steam generating units. According to § 112(n), when EPA determines that regulation of emissions from power plants is appropriate and necessary under § 112(n)(1)(A), EPA is to regulate such emissions. Under the framework of § 112(n), EPA is to do so by developing and implementing alternative control strategies that address reasonably anticipated hazards posed to public health. That the statute does not expressly instruct EPA to implement such strategies does not mean that Congress intended EPA to regulate such emissions under § 112(d). Had Congress intended for EPA to regulate under § 112(d), the requirement that EPA develop and report alternative control strategies would be nothing more than a meaningless exercise. Such cannot be not the case. Congress imposed the requirement that EPA develop and report alternative control strategies because it intended that EPA implement them, not that it regulate them under the framework of § 112(d). *See Public Lands Council v. Babbitt*, 120 S. Ct. 1815, 1826 (2000) ("Why would Congress add the words . . . if . . . they add nothing?"); *Moskal v. United States*, 498 U.S. 103, 109-10 (1990) (recognizing the "established principle that a court should ' give effect, if possible, to every clause and word of a statute.' ").

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6 Section 112 provides EPA with discretion to set risk-based standards for the control of HAP emissions from all source categories and subcategories and the ability to rem ove from regulation low risk source categories. *See* 42 U.S.C. § 7412(d)(4); § 7412(c)(9).

7 The term "major source" means any source "that emits or has the potential to emit, . . .in the aggregate, 10 tons per year or more of any hazardous air pollutant or 25 tons per year or more of any combination of hazardous air pollutants." 42 U.S.C. § 7412(a)(1).

8 A&P Cong. Record E3670, E3671.

2. EPA Has Discretion Under The More Flexible Framework Of § 112(n) To Implement Alternative Control Strategies For Emissions, Such As A System-Wide Performance Standard, As Long As EPA's Strategies Address The Risk Of Harm That § 112(n) Was Intended To Ameliorate.

Section 112(n) does not prohibit EPA from implementing a system-wide or pooled performance standard with regard to mercury emissions from power plants. Rather, section 112(n) confers discretion on EPA by permitting it to develop alternative control strategies for emissions from electric utility steam generating units rather than forcing power plant HAP regulation into the rigid, technology-based framework of § 112(d).[9] Section § 112(n)(1)(A) calls for EPA to potentially regulate electricity generator HAP emissions as the final step in a three-part process. As EPA acknowledged in the Report to Congress mandated by the provision,[10] § 112(n) calls for EPA to:

1. Perform a study of the health impacts of HAP emissions from electric utility steam generating units;[11]

2. "develop and describe . . . alternative control strategies for [HAP] emissions which [on the basis of the study of health hazards] may warrant regulation under this section";[12] and

3. "regulate electric utility steam generating units under this section, if the Administrator finds such regulation is appropriate and necessary after considering the results of the study required by this subparagraph."[13]

Put simply in the context of mercury emissions, EPA's first duty was to study the hazards to public health reasonably anticipated to occur as a result of mercury emissions from power plants. EPA was then required to develop alternative strategies for controlling mercury emissions and report them to Congress. Finally, upon EPA's determination that regulation of mercury emissions is appropriate and necessary, § 112(n) requires EPA to regulate. EPA must do so under the framework created by Steps One and Two: EPA must address hazards to public health identified in Step One and may do so by way of alternative control strategies developed pursuant to Step 2.

Notably, nothing in § 112(n) requires that EPA control each source as § 112(d) arguably does.[14] Therefore, to the extent that EPA has interpreted § 112(d) as prohibiting a system-wide

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9 42 U.S.C. § 7412(n)(1)(A).

10 EPA, "Study of Hazardous Air Pollutant Emissions from Electric Utility Steam Generating Units – Final Report to Congress," EPA-453/R-98-004a, February 1998, Volume 1 at ES-1.

11 *See* 42 U.S.C. § 7412(n)(1)(A).

12 *Id.*

13 *Id.*

14 42 U.S.C. § 7412(d)(1). EPA has implicitly taken the position in prior MACT standards that a system-wide or pooled performance standard is not permitted under CAA § 112(d). Nonetheless, there is nothing in § 112(d) that expressly requires that each source be subject to controls. Thus, a system-wide standard arguably is allowable under § 112(d) as well.

performance standard, there is no such limitation in § 112(n)(1). Having established that § 112(n) does not prohibit a system-wide or pooled performance standard, the appropriate inquiry is whether source-specific reductions are necessary to address the hazards that § 112(n) was intended to ameliorate.

C. A System-Wide Performance Standard Is Permissible Under § 112(n) Because Unit-Specific Reductions Are Not Necessary To Address Risks Associated With Power Plant Mercury Emissions

Unit-specific, or even facility-specific, reductions of mercury emissions are not necessary to reduce the risk of harm that regulation pursuant to § 112(n)(1)(A) is intended to address. To the extent that mercury emissions from power plants pose a hazard to public health, they do so almost entirely as a result of their contribution to the mercury "global pool," not from "hot spots" created through local deposition.[15] A system-wide performance standard is consonant with § 112(n) because it would not affect the net contribution by U.S. power plants to the global pool of mercury emissions.

1. According To EPA, U.S. Power Plants Contribute Only Negligibly To Human Mercury Exposures.

In its Mercury Study Report to Congress, EPA estimated worldwide emissions of mercury in 1995 to be approximately 5,500 Mg.[16] These emissions were derived from natural sources, such as the release of geologically bound mercury, anthropogenic sources, and re-emission by mass transfer of mercury already deposited on the earth's surface.[17] EPA estimated that 50 to 75 percent of total yearly output was derived from all anthropogenic sources combined.[18]

EPA further estimated that total 1995 anthropogenic emissions from all human sources in the United States totaled 158 Mg.[19] Thus, according to EPA's estimate, in 1995 U.S. anthropogenic sources accounted for no more than approximately 3 percent of total worldwide mercury emissions in that year.[20] According to EPA, coal-fired power plants were responsible for 46.9 Mg of this emissions total, while municipal waste combustion accounted for 26.9 Mg, commercial/industrial boilers for 25.8 Mg, and medical waste incinerators for 14.6 Mg.[21] EPA's estimates demonstrate that coal-fired power plant boilers were responsible for less than 30

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15 The potential to identify selected hot spots issues near specific sources of mercury emissions need not foreclose a system-wide compliance provision. The regulations could expressly provide that, in the rare event that EPA identifies hot spots near specific sources, EPA may simply disallow those sources from being included in the system or pool.

16 EPA, *Mercury Study Report to Congress* at I, 0-1 (Dec. 1997) ("The Mercury Study Report").

17 *Id.* at I, 2-1.

18 *Id.* at III, 2-3.

19 *Id.* at I, 0-1.

20 *Id.*

21 *Id.* at III, 2-8.

percent of United States anthropogenic mercury emissions in 1995, and less than 1 percent of worldwide anthropogenic mercury emissions in that year.

Applying a computer model of long-range mercury transport, EPA estimated that 52 Mg of U.S. anthropogenic emissions in 1995 were deposited within the lower 48 states, with the remainder transported outside the U.S.[22] Using the same computer modeling, EPA estimated that 35 Mg of mercury were deposited from non-U.S. sources, suggesting that slightly more than 67 percent of U.S. mercury deposition in 1995 was derived from U.S. sources.[23]

The amount of local deposition of mercury is in part a function of the speciation of the mercury emitted from the source. Mercury is typically emitted both in its elemental form and as oxidized mercury. When emitted from facilities with tall stacks, such as power plants, the distance that mercury travels from its source depends largely on its form at the time it is emitted. Elemental mercury tends to enter the global mercury cycle, and may be retained in the atmosphere for up to one year before deposition, creating the possibility that it will travel around the earth several times before deposition.[24] Elemental mercury deposition is presumed to "be distributed fairly even[ly] in the troposphere."[25] Oxidized mercury, on the other hand, is more likely to deposit relatively quickly, suggesting the possibility of local or regional deposition shortly after emission.[26]

2. EPA's Computer Modeling Of Mercury Deposition Suggests That Local Deposition Attributable To Coal-Fired Power Plants Is Negligible.

In its 1997 Mercury Study Report, EPA undertook extensive computer modeling in order to predict the environmental fate of mercury emitted from the stacks of combustion sources.[27] EPA acknowledged that a modeling approach was necessary, given the lack of actual data regarding mercury deposition from specific combustion sources.[28] One model used by EPA, ISC3, was applied in order to predict the average annual atmospheric mercury concentration and deposition fluxes within 50 km of the mercury emission source.[29] In its ISC3 modeling, EPA recognized that elemental mercury "is not expected to deposit close to the facility. In contrast, [oxidized mercury] is expected to deposit in greater quantities closer to the emission sources."[30] Rather than use actual emission sources in its models, EPA developed

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22 *Id.* at I, 0-1.

23 *Id.*

24 *Id.* at 2-4.

25 *Id.* at 2-7.

26 *Id.*

27 *Id.* at I, 0-1.

28 *Id.* at 3-31. As EPA stated, "[t]hese data are not derived from a comprehensive study for mercury around the sources of interest. Despite the obvious need for such an effort, such a study does not appear to exist." *Id.*

29 *Id.* at 4-1.

30 *Id.* at 4-16.

several model plants, hypothetical facilities intended to simulate actual emission sources, including municipal waste combustors, coal and oil-fired boilers of different sizes, medical waste incinerators, and chlor-alkali plants.[31] These model plants were designed to simulate source emissions in both humid and arid locations to reflect the assumed greater deposition of oxidized mercury in locations with more precipitation.[32]

In configuring its model large coal-fired plant, EPA assumed a stack height of 223 meters, and an emission speciation of 50% elemental mercury, 30% oxidized mercury vapor, and 20% particulate oxidized mercury.[33] Given these assumptions, EPA predicted that at its hypothetical "humid" plant location, only 6.7% of total mercury emissions would be deposited within 50 km of the stack.[34] At its hypothetical "arid" plant location, even less mercury was predicted to deposit locally, with EPA estimating that only 2.1% of total emitted mercury would deposit within 50 km of the stack.[35]

Similarly, in configuring its model of a medium coal-fired plant, EPA assumed a stack height of 142 meters, with an emission speciation of 50% elemental mercury, 30% oxidized mercury vapor, and 20% particulate oxidized mercury.[36] At its "humid" location, EPA predicted that only 8.5% of total emitted mercury would be deposited within 50 km of the stack, while at its "arid" site, only 3.7% of total emitted mercury would be deposited within this radius.

Finally, in configuring its model of a small coal-fired plant, EPA assumed a stack height of 81 meters, and the same emission speciation of 50% elemental mercury, 30% oxidized mercury vapor, and 20% particulate oxidized mercury.[37] Based on these assumptions, EPA predicted that at its "humid" site, 13.7% of total emitted mercury would be deposited within 50 km of the stack.[38] At its "arid" site, EPA predicted that 8.5% of total emissions would be deposited within this radius.[39]

Based on these predictions, EPA stated that for <u>all</u> power plant boilers "*less than 15 percent of the total mercury emitted is predicted to deposit within 50 km* [due to] the high effective stacks predicted for this source class."[40] More broadly, EPA concluded that "[b]ased on the local scale atmospheric modeling results in flat terrain, *at least 75 percent of the emitted mercury from each facility [including all emission sources] is predicted to be transported more*

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31 *Id.* at 4-21.

32 *Id.* at 4-22.

33 *Id.* at 5-42.

34 *Id.* at 5-42.

35 *Id.* at 5-43.

36 *Id.* at 5-42.

37 *Id.* at 5-42.

38 *Id.* at 5-42.

39 *Id.* at 5-43.

40 *Id.* at 5-44 (emphasis added).

than 50 km from the facility."[41] In 1998, EPA presented even lower estimates of local deposition. In its *Utilities Report to Congress*, EPA stated that "[a]n estimated *5 to 10 percent of primary [oxidized] Hg(II) emissions are deposited within 100 km of the point of emission* and a larger fraction on a regional scale."[42] In its *Utilities Report*, EPA also noted that "*most of the mercury emitted to the atmosphere is deposited more than 50 km away from the source*, especially sources that have tall stacks."[43]

It should be further noted that, in contrast with EPA's assumed speciation percentages, the Electric Power Research Institute has estimated that in 1999, the 45 tons of mercury emitted by coal-fired power plants consisted of 26 tons of elemental mercury (57%), 18 tons of oxidized mercury (40%), and less than one ton of particulate mercury (2%).[44] Given that elemental mercury is substantially less likely to deposit locally, EPRI's estimate suggests even less local deposition than does EPA's model.[45]

3. Relatively Recent Studies of Mercury Deposition Do Not Support Claims Of Significant Local Deposition From Coal-Fired Sources.

Despite its own low estimates of local mercury deposition due to emissions from coal-fired power plant boilers, EPA has stated that "studies in the Great Lakes region and in Florida show that mercury emissions on local scales can greatly influence loadings in some locations when local sources have significant emissions of divalent and particulate forms of mercury. For example, the South Florida Atmospheric Mercury Monitoring Study . . . was able to demonstrate that local anthropogenic sources strongly influence mercury wet deposition levels."[46] Similarly, in a study of atmospheric deposition of several toxics in the Great Lakes, it was suggested that approximately 80 percent of mercury found in Lake Michigan comes from atmospheric deposition, with "localized sources, such as Chicago, contribut[ing] approximately 30 percent of the total regional atmospheric loading to the lake."[47] Significantly, there is no

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41 *Id.* at 7-4 (emphasis added).

42 EPA, *Mercury: Utilities Report to Congress* (1998) at 7-5 (emphasis added).

43 *Id.* at 7-45 (emphasis added). Nonetheless, EPA also concluded that in some circumstances, "deposition within 10 km of a facility is [sic] may be dominated by emissions from the local source." *Id.* at 7-4. At no point, however, does EPA make such a suggestion with regard to coal-fired power plant sources. *See id.* (giving example of chlor-alkali facilities as source of dominant local deposition).

44 EPRI, *An Assessment of Mercury Emissions from U.S. Coal-Fired Power Plants*, at xiv (2000) (utilizing data gathered as a result of EPA's 1998 Information Collection Request).

45 *See also* EPRI, *Assessment of Mercury Emissions, Transport, Fate and Cycling for the Continental United States* (Dec. 2000) (finding that "[t]he average speciation developed from the ICR for coal-burning utilities [was] 54/44/2 for bituminous, 56/42/2 for anthracite . . and 75/24/1 for other coals").

46 EPA, *Deposition of Air Pollutants to the Great Waters: 3rd Report to Congress*, at II-8 (2000).

47 Delta Institute, *Atmospheric Deposition of Toxics in the Great Lakes: Integrating Science and Policy*, at 2 (2000) (citing Mason & Sullivan, *Mercury in Lake Michigan*, Envir. Sci. & Tech. 31:942 (1997)).

apparent attempt made in these studies to differentiate between emissions sources other than to refer to "localized sources, such as Chicago," which would include chlor-alkali facilities, municipal waste combustion, medical waste incinerators, and other sources. Given EPA's own acknowledgement that mercury emission sources other than coal-fired power plant boilers are likely to be responsible for substantially more local deposition than coal-fired sources, no conclusions can be drawn from these studies that would suggest significant local deposition due to such coal-fired emissions sources. Indeed, given EPA's modeling of power plants as compared to other sources, it seems highly likely that local sources other than power plants are responsible for those loadings. For example, EPA in its *Mercury Report* predicted that its model small hospital medical waste incinerator would deposit 43.3% of its total emitted mercury within 50 km of the "humid" source location.[48]

Similarly, in a 1998 study, Swedish and Chinese scientists surveyed mercury deposition at a nature reserve "surrounded by six large scale industrial Hg producer [sic] at distances from about 25 to 200 km."[49] This study determined that "Hg concentrations in the air, soil and moss are all several hundred times higher than the corresponding background levels .... Considering the distance between [the emissions sources and the nature reserve] it would be no doubt [sic] that Hg emitted to the atmosphere would have been deposited to [the reserve]."[50] Nonetheless, the emissions sources in the Fanjing study appear to have been mercury mines and mercury production facilities, and the authors of the study explicitly cautioned that "[t]he contributions from other Hg producer [sic] ... are unclear, especially the part from coal burning, the potentially biggest emission sources in this province."[51] Here again, as the study's authors suggest, there is no evidence supporting a finding of significant local deposition from coal-fired power plants.

In another report, the Minnesota Pollution Control Agency stated that based on an unpublished study, "[l]akes in the urban and suburban areas of Minneapolis-St. Paul may receive about 35% more mercury deposition due to the aggregate of local emissions."[52] Nonetheless, the Minnesota study does not attempt to differentiate the specific sources responsible for this possibly elevated local deposition, and makes no conclusions regarding the amount of deposition attributable to coal-fired sources. Similarly, a study by the Chesapeake Biological Laboratory observed that "[l]ocal sources may also contribute to the variability [in mercury deposition at one monitoring site]. Waste incinerators and power plants are known point sources of Hg, and there is at least one of each in close proximity to [this site]."[53] However, the Maryland study fails to differentiate or even make an attempt to quantify the amounts of deposition purportedly derived

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48 *Mercury Study Report* at 5-42.

49 Xiao, Sommar, & Lindqvist, *Atmospheric Mercury Deposition on Fanjing Mountain Nature Reserve*, Chemosphere, Vol. 36, No. 10, at 2191-2 (1998).

50 *Id.* at 2195.

51 *Id.* at 2199.

52 Minnesota Pollution Control Agency, *Report on the Mercury Contamination Reduction Initiative Advisory Council's Results and Recommendations*, at 49-50 (March 1999).

53 Mason, Lawson, & Sheu, *Annual and Seasonal Trends in Mercury Deposition in Maryland*, Atmospheric Environment 34:1691, at 1698 (2000).

from power plants as opposed to waste incinerators. Thus, the Maryland study similarly fails to make a case for significant local deposition from coal-fired emissions sources.

In contrast, data suggest that coal-fired emissions sources are not a significant source of local mercury deposition. In addition to EPA's own results, which suggest a very low rate of local deposition for mercury emitted from coal-fired power plants, other studies have also suggested that local deposition is not generally significant. In a 1998 study, a study by the Northeast States for Coordinated Air Use Management using EPA's computer modeling estimated that only 13 percent of Northeast regional emissions of mercury were derived from electric power plant boilers.[54] In addition, the Minnesota study cited above found that "[i]t is thought that more than half of the mercury deposited in Minnesota is global atmospheric contamination that remains in the atmosphere for up to a year before it is deposited. It is estimated that *10% of the deposition in Minnesota is due to mercury emitted in Minnesota.*"[55] On the basis of these findings, the Minnesota Pollution Control Agency found that "a 50% reduction in mercury air emissions in Minnesota is estimated to result in a 5% reduction in mercury deposition in the state."[56] Significantly, these figures include *all* mercury emissions in Minnesota, and thus the emissions from electric power plant boilers would account for even less than the 10% deposition figure estimated by the agency.[57]

There is also growing evidence that concentration levels of methylmercury itself tend to be fairly uniform compared to deposition levels of oxidized mercury, suggesting that local emission sources may not be creating methylmercury "hot spots" at all. For example, EPA observed that in a 1998 study, researchers sampled mercury contamination in fish populations in Green Bay, Lake Michigan, and found that "[t]he overall distribution of mercury tissue concentrations was fairly uniform within the bay, *indicating that mercury contamination originates primarily from non-point sources, including atmospheric deposition.*"[58] Similarly, the Maryland study cited above found that "[w]hile seasonality and local sources appear to impact total Hg in wet deposition, there appears to be less variability in the MMHg [methylmercury] concentration and flux. Although there is less data for MMHg, the results suggest no strong . . . differences between the urban and regional sites . . . . Thus, it does not appear that urban sources are as important a source of MMHg as they are for total Hg."[59] These results indicate that there

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54 NESCAUM, *Atmospheric Mercury Emissions in the Northeastern States*, February 1998, http://www.nescaum.org/pdf/mercury.pdf (last visited, June 8, 2001).

55 Minnesota Pollution Control Agency, *Report on the Mercury Contamination Reduction Initiative Advisory Council's Results and Recommendations*, at 10 (March 1999) (emphasis added).

56 *Id.*

57 Extrapolating from EPA's own estimates of nationwide source contributions of mercury emissions, *see* n. 20 *supra*, coal-fired sources in Minnesota would be responsible for only 2.9% of Minnesota's total anthropogenic mercury deposition.

58 EPA, *Great Waters: 3rd Report*, at II-17 (emphasis added).

59 Mason, Lawson, & Sheu, *Annual and Seasonal Trends in Mercury Deposition in Maryland*, at 1698 (2000). It is also worth noting that EPA has stated that "new measurement methods suggest that natural mercury emissions rates from mercury-rich soils and bedrocks may be larger than past estimates," further suggesting that current anthropogenic emissions may be responsible for

may be no demonstrable correlation between local deposition of mercury and local concentrations of methylmercury, further underscoring the absence of any linkage between coal-fired emissions sources and local mercury "hot spots."

Most recently, data published by the Electric Power Research Institute, Inc. ("EPRI") suggest that, when emitted from power plants, oxidized mercury may rapidly transform in ambient air to elemental mercury, further supporting the conclusion that mercury hot spots from power plants are unlikely to occur.[60] Underscoring the tenuousness of the link between mercury emissions from power plants and hot spots is EPRI's conclusion that if electricity generators in the U.S. were to reduce mercury emissions by nearly half – from 49 tons per year to 24 tons – the cut would only achieve a 3 percent reduction in actual mercury deposits in the U.S. including fresh water lakes, rivers and streams.[61] Wild fresh water fish in the U.S. would be expected to show greater reduction in mercury content than ocean or farmed fish, but wild fresh water fish are a relatively small part of the U.S. diet.[62] Therefore, "a drop of nearly half in utility mercury emissions results in a drop of 3 [percent] (on average) in mercury depositing to the ground, and a drop of less than one-tenth of a [percent] in the number of children 'at risk' [who would be born to mothers consuming fish with lower mercury levels]."[63]

In sum, the above-referenced studies show that, to the extent that power plant mercury emissions pose a hazard to human health, the risks are quite small and finite. In addition, data show that hazards to human health due to local deposition of mercury from power plants are negligible. Therefore, unit- or facility-specific reductions in mercury emissions are not necessary to reduce associated risks of harm to public health. EPA's authority to regulate power plant mercury emissions pursuant to CAA § 112(n) requires that EPA address the harm posed by mercury emissions from power plants. Hazards posed to human health in the U.S. by mercury emissions from power plants are almost exclusively due to the contribution of mercury emissions to the global pool. EPA's ultimate goal, therefore, should be to reduce total contribution of power plant mercury emissions to the global pool. EPA may do so through the implementation of system-wide or pooled performance standards.

D. Public Policy Supports The Implementation Of A System-Wide Performance Standard For Mercury Emissions From Power Plants

In addition to being supportable on legal grounds, a system-wide or pooled performance standard represents sound public policy. Achievements obtained through EPA's Acid Rain Programs for sulfur dioxide ("SO_2") emissions and nitrogen oxide ("NO_x") emissions

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less total mercury emitted than EPA had previously argued. EPA, *Great Waters: 3rd Report*, at II-5.

60 Dennis L. Laudal, *JV Task 24 – Investigation of the Fate of Mercury in a Coal Combustion Plume Using a Static Plume Dilution Chamber*, 2001-EERC-11-01, at 32 (November 2001), *at* http://www.netl.doe.gov/coalpower/environment/air_q/docs/SPDC-Rpt.pdf.

61 Leonard Levin, Ph.D., *Remarks to the Committee on Environment and Public Works, United States Senate* (July 29, 2003).

62 *Id.*

63 *Id.*

demonstrate that emissions averaging and its functional equivalent, emissions trading, are effective techniques for meeting or exceeding environmental objectives at lower cost and with greater flexibility tailored to individual affected facilities. For example, to regulate SO_2 emissions pursuant to the Acid Rain Program, the CAA imposed a nationwide cap for emissions from U.S. electric power plants. As mandated by the CAA, EPA has implemented a system whereby facilities may trade allowances for SO_2 emissions.[64] As a result of the trading program, facilities have successfully and efficiently reduced SO_2. The "cap-and-trade" system has given facilities flexibility to implement the most efficient compliance methods and has encouraged technological innovation.[65] According to EPA, the program's flexibility has reduced significantly the cost of achieving SO_2 emissions reductions relative to the cost associated with a technology-based rule or fixed-emission rate.[66]

Notably, EPA's 2001 Progress Report observed that, under the trading program, there were no significant geographic shifts in emissions.[67] Such evidence suggests that a system-wide standard for mercury emissions will not cause shifts in mercury emissions that could create or aggravate any potential hazards associated with hot spots. In addition, EPA reported virtually total compliance in 2001. Of 2,792 regulated sources, all but two complied with the programs emissions requirements[68] – a compliance rate of 99.93%.[69] A comparable rate of compliance has not been achieved to date under traditional command-and-control programs.

Similar efficiencies are being achieved under EPA's Acid Rain Program regulating NO_x emissions. Title IV of the 1990 Clean Air Act establishes requirements for the reduction of NO_x emissions from coal-fired electric generating units. Under the program, regulated electricity generators are permitted to select, among other options, an emissions averaging compliance alternative.[70] Companies opting to meet emissions requirements through emissions averaging comply by choosing to make a group of NO_x affected boilers subject to a group NO_x limit rather than meeting individual NO_x limits for each unit.[71] The Acid Rain NO_x program is a reasonable model upon which EPA may base a system-wide or pooled performance standard for mercury emissions. Should EPA decide to implement such a standard, an averaging technique similar to the one implemented in the Acid Rain NO_x program would be appropriate. The Acid Rain NO_x program's emissions averaging provision requires sources to demonstrate compliance based on the following equation:

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64 EPA, *Acid Rain Program: 2001 Progress Report* at 2 (Nov. 2002).

65 *Id.* at 12.

66 *Id.*

67 *Id.* at 5.

68 *Id.*

69 EPA reported a comparable compliance rate with the Acid Rain NO_x program. Of 1,045 affected sources, all but one failed to meet its NO_x emissions limits in 2001 – a compliance rate of 99.90%. *See id.* at 18.

70 *Id.* at 17.

71 *Id.*

$$\frac{\sum_{i=1}^{n}\left(R_{ai}\times HI_{ai}\right)}{\sum_{i=1}^{n}HI_{ai}} \le \frac{\sum_{i=1}^{n}\left(R_{li}\times HI_{ai}\right)}{\sum_{i=1}^{n}HI_{ai}} \qquad \text{(Equation 2)}$$

where:

R_{ai} = Actual annual weight averaged emission rate for unit i, lb/mmBtu, as determined using the procedures in part 75 of this chapter. For units in an averaging plan utilizing a common stack pursuant to § 75.17(a)(2)(i)(B) of this chapter, use the same NO_x emission rate value for each unit utilizing the common stack, and calculate this value in accordance with appendix F to part 75 of this chapter;

R_{li} = Applicable annual emission limitation for unit i lb/mmBtu, as specified in § 76.5, 76.6, or 76.7, except that for early election units, which may be included in an averaging plan only on or after January 1, 2000, R_{li} shall equal the most stringent applicable emission limitation under § 76.5 or 76.7;

HI_{ai} = Actual annual heat input for unit i, mmBtu, as determined using the procedures in part 75 of this chapter;

n = Number of units in the averaging plan.

40 C.F.R. § 76.11(d)(1)(ii)(A) (2003). This protocol for emissions averaging would be appropriate, with one change: the mercury emissions rate of a given unit should be weight-averaged by heat input before being averaged with other emissions units in the pool. Accordingly, R_{ai} should be defined as the actual annual weighted averaged emission rate for unit i, lb/mmBtu, as determined using the procedures in Part 75 of Chapter 1, *except that each hour's emissions rate shall be prorated by heat input for that hour.* As with the Acid Rain Program, the "pool" of units could include units from two or more facilities under common ownership or operator control.[72]

As with the Acid Rain NO_x program, by giving sources of mercury emissions flexibility to meet emissions standards, EPA will address the risk of harm posed by such emissions as required by § 112(n), providing equivalent environmental benefits but reducing compliance costs by permitting sources to choose the most efficient means of compliance.

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[72] *See* 40 C.F.R. § 76.11(a) ("In lieu of complying with the applicable emission limitation in § 76.5, § 76.6, or 76.7, any affected units subject to such emission limitation, under control of the same owner or operator, and having the same designated representative may average their NO_x emissions under an averaging plan approved under this section.").

E. Conclusion

We appreciate the opportunity to submit this white paper in support of a system-wide performance standard for mercury emissions from electric utility steam generating units. Nothing in § 112(n) prohibits such an alternative; rather § 112(n) permits it because a system-wide or pooled performance standard will not affect the risk of harm to public health upon which EPA's authority to regulate is premised and which § 112(n) regulation is intended to ameliorate. Scientific data establish that the risk of harm associated with mercury emissions from power plants is almost exclusively due to the contribution of such sources to the mercury emissions global pool, not from hot spots near sources of emission. Therefore, a system-wide performance standard that does not affect the overall emissions reductions required by EPA would be entirely consistent with § 112(n)'s design to address the harm posed by mercury emissions. In addition, public policy favors the implementation of such a scheme. Use of cap-and-trade and source-wide emissions averaging in programs such as the Acid Rain Program demonstrates that such compliance alternatives achieve the desired environmental objectives at lower cost by giving sources flexibility to choose the most efficient means of compliance.